VOL. 29 NO. 2

BULLETIN

OF THE

TORREY BOTANICAL CLUB

FEBRUARY 1902

On the Teaching of Vegetable Pathology*

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It is generally recognized at the present time that the scientific man has not completed his labors when he has determined to his own satisfaction what the solution of any particular phenomenon in which he is interested, may be. The time was when it was considered sufficient for him to publish his results in an abstract form where a few of his colleagues might read and understand them. To-day we regard it as one of the duties and privileges to make accessible to those not immediately engaged in one particular line of research, the results of the work in the laboratory and the field.

I take it, that as many of us are engaged in teaching the various branches of botanical science to students, it may be a legitimate question to discuss before this Society what we are doing with our college classes, and how we can best accomplish our object. It is my purpose to-day to bring before you for discussion, some thoughts as to how we can best train those who intend to devote themselves to the study of vegetable pathology.

Of the several lines of botanical research, that which is generally termed vegetable pathology is beginning to claim more general attention at this time. Courses are being offered in some of our colleges and universities, which deal with diseases of plants, although for the most part these are mere adjuncts of courses in

* A paper read before the Society of Plant Morphology and Physiology, New York. 31 December 1901.

[Issued 25 February]

cryptogams. The time is not far distant, however, when vegetable pathology as a separate branch of botanical science will assert itself and claim recognition independent of the other branches of this science, and when we will have professors of pathology, who will devote their time and attention to this subject alone. At the present time the demand for properly trained men to take up work in the study of plant diseases is increasing every year, and with the rapid development of scientific agriculture, economic questions involving the study of plant pathology are becoming more numerous, and demand more urgent solution. The economic side alone will be sufficient to bring about radical changes in the present condition of this science in our institutions of higher education.

By vegetable pathology I mean to imply the study of plant diseases in its widest sense. It is perhaps not easy to define disease accurately, but for our present purposes, it will be sufficient to speak of disease as abnormal physiology, or, as it has been termed by Marshall-Ward, "a variation of functions in directions which threaten the life of the plant."

It is essential that we understand at the outset that we are dealing with a living plant and the reactions which its parts show toward environmental conditions. What we are studying are diseased *plants*, as distinguished from disease-causing factors. This is to be the fundamental conception of this paper. We have been studying mildews and rusts long enough, and in so doing made ourselves believe we were studying pathology, and it is high time that it were realized that the patient is after all more important than the disease-bringing factor. Assuming that all are agreed upon this point, and taking this as a starting-point, let us inquire how we can go about to teach this conception of pathology. It is evident that a knowledge of the morphology of fungi will not be sufficient, and that a very different method must be adopted from the one in vogue in many of our colleges at this time.

In the first place let me say that we can learn much from the kindred science of animal pathology. The study of this subject is generally divided into three groups: (1) Diagnosis, (2) Etiology, (3) Therapeutics. In all cases the living object is first consulted, then the causal factors, and lastly the remedy. Applying this to plants we find that the symptoms of disease are on the whole not

as sharply defined as in animals. This is due in part to the lower degree of organization of the plant, and also to the fact that a good many disturbing factors give rise to similar symptoms. We can, however, analyze the symptoms with far greater ease than is possible in animals. Environmental conditions can be controlled, and by a method of elimination the disturbing factor can be determined positively. The study of the disturbing factor, whether it be environmental or due to living organisms, can also be carried on with more success with plants than with animals. In other words, we can make the study of pathology one involving experimentation with living plants.

This brings me to speak of the things necessary for a course in pathology conforming to the above. In the first place one or more greenhouses are absolutely essential, together with a liberal supply of living plants. If carried on in the spring and summer the greenhouse is not so essential. Access to greenhouses where different kind of plants are growing is also desirable. In St. Louis we have established a vegetable clinic, where patients are received and observed. The greenhouse, or houses, ought to be divided into numerous compartments, each completely sealed from the others preferably, so as to prevent the spreading of fungus spores. I wish to call attention to a series of houses built by Dr. von Tubeuf at Dahrlem, near Berlin, which are ideally arranged for work in experimental pathology. The number and kind of plants needed depend largely upon the amount of work which one contemplates doing. Wheat, corn, oats, cabbages, roses, lettuce, cotton, and other common plants easily obtained, will be found ample in most cases. Living material of fungi, obtained from diseased plants, or kept as cultures, will also be essential.

Before proceeding further a word ought to be said about the preparation which we ought to expect of students engaging in this study. As pathology is essentially abnormal physiology, a thorough knowledge of plant physiology should be required. This is so obvious that it is hardly necessary to urge it, and yet it is a curious fact that, so far as I have been able to determine, this is demanded, and that not very decidedly, in only one institution. Too much stress cannot be laid on this requirement, and under no consideration ought pathology, as we now understand it, to be

studied without physiology as a basis. I can leave this part by simply referring to the absurdity of a medical student studying human pathology without understanding the circulation of the blood. Next in importance comes a knowledge of chemistry, and preferably at least a year of organic chemistry, and a knowledge of physics. Physiological problems are becoming more and more physico-chemical problems, and a thorough understanding of these sciences is absolutely essential. A good reading knowledge of modern languages, an understanding of the morphology of higher plants, and if possible of fungi and bacteria, together with an ability to grow fungi and bacteria may complete the list. This preparation would mean that a course in pathology could not be begun until the senior year or thereafter.

Coming now to the main subject as to what we are to teach, I would simply offer a few broad suggestions. It really does not make much difference as to how the subject is divided, so long as some of the fundamental conceptions of disease are included. The amount of work which one will be able to accomplish will depend upon the individual. I believe firmly that we ought to train a student so that he can think and work for himself, and that this should be kept uppermost at all times. It is impossible in the course of a year to study all diseases of plants, and granting that this is true, we must select certain fundamental facts to impress upon the student, allowing him to work out many others for himself later on. Such fundamental facts are the cause of disease, the symptoms of disease, the way in which diseases spread, the prevention of disease, and the nature of disease. In his treatise on the Diseases of Plants recently issued, Professor Marshall Ward has discussed the topics just mentioned in a suggestive manner, and in a way not presented before.

Taking it for granted that the student is familiar with the normal physiological behavior of a cell and cell-groups, one may begin the study of disease by noting the change in single cells or cell-groups under abnormal conditions, and the reactions which are induced by these conditions. The study of wounds offers a very fruitful field for the beginner, for we find in a wound one set of changes which cells undergo when diseased. The irritable nature of the cell which enables it to form a protection against the

air, and later on the protecting cork layer and the callus is fully brought out in that connection. I have found succulent stems and leaves very good for the study of wounds, particularly the leaves of the cauliflower. In this connection the wounds caused by insects can be studied, and the peculiar response which the living tissue makes to the disturbing cause. Plant lice abound everywhere, and so do gall flies, so that there is never any trouble in getting living material for study. Following this one may observe the influence of living organisms in cells, for instance, the manner in which the various Chytridiaceae influence the leaf tissue. From these one may continue with the more complex reactions of fungi like *Albugo*, *Exoascus*, and *Gymnosporangium*. With all of these it is possible to keep the fungus, and the leaves attacked, under constant observation. With some it is not easy, for instance the *Exoascus* and *Gymnosporangium;* these had best be observed out-of-doors in the spring; with a little judicious planning it is feasible to postpone the study of these complex reactions until the latter part of the course. *Albugo* and *Synchytrium* can be grown on plants in greenhouses. Very different from the influence exerted by these fungi is that exerted by others like *Botrytis*, the Uredineae, and the Peronosporeae. It will be sufficient for me to refer to this simply, as the reasons why these should be included are obvious enough.

If time permits, the changes in cell-groups near wounds and spots attacked by fungi can be studied, *i. e.*, the formation of wound gums, the increased evolution of heat and the rapid transformation of plastic food bodies, the accumulation of starch, etc.

A second line of work grows out of the question as to what causes disease. This question involves most of the others mentioned above, and can be made the starting point for all. Using the convenient division of disease caused by the action of either environmental factors of living organisms, one can begin by experimenting with unfavorable environmental conditions. In doing so it is of course hardly necessary to say that great care must be used in devising experiments which will give definite results. To illustrate: if the influence of excessive heat is to be studied, one must be sure that the light, moisture and gaseous conditions are the same. As a rule it will prove most satisfactory to work with

those factors which can be most readily handled, for it is after all, as has been said, the method of study that we are after, rather than a long series of facts. This part of the work can of course be carried on hand-in-hand with that part first suggested, for it is not possible to separate cause and effect.

Coming next to the influence of living organisms, a large field is opened with any number of possible lines of work. One of the first points to be demonstrated is that fungi or bacteria are the causes of disease. For this purpose it is well to select a fungus which grows readily and reproduces rapidly. There are a number of these. This fall we found *Erysiphe graminis* growing on wheat, a most interesting fungus to work with. I can perhaps make my meaning clearest by relating briefly what we did. A preliminary discussion brought out a number of questions which we desired to answer, such as: (1) Does this fungus produce the disease of wheat which it was found connected with, *i. e.*, will it make perfectly healthy plants diseased? (2) How does it do so; in other words, what is the relation of the fungus and the wheat leaf? (3) Will the spores of the fungus produce the disease in other plants besides the wheat plant, for instance oats, rye, wheat, *Poa*, corn, roses, etc. (4) Is there any connection between the ease with which this fungus attacks the wheat, and the condition of the plant to be infected? (5) What factors favor development of the fungus? Will the fungus grow on dead leaves? (6) How does the spore get from plant to plant? (7) What are the factors which determine germination of the spores?

Each student was instructed to find a method for answering these questions, and such others as arose, and as a result we had a series of experiments started, which were watched with the utmost interest. The questions dealt with broad subjects applicable to most other fungi or disease-causing factors. The results showed that the fungus does produce the disease, and thereby answered one of the most important questions. To the average mortal "seein' is believin'," and when a student actually sees himself producing the disease in question, as he thinks, the impression gained is that of the original investigator, and is apt to be remembered. The results brought into discussion the problem of susceptibility, both of plant races and individuals; it was found that

of all the plants the wheat alone was attacked, and again that the stronger plants were less liable to attack. Again it was found that crowding helped the fungus, that moisture and warmth had the same effect, and that the spores could germinate in a drop of water. We spent a long time studying *Erysiphe graminis*, but I believe that the results amply warranted our doing so.

One might have used other fungi, for instance the clubroot of the cabbage, the cotton wilt, and others, bearing in mind that rapid growth is desirable, for when you have to wait six months or more the interest is liable to wane.

Having carried on one series such as the one described, it may be well to continue with as many more as one may have time for. Where live material of the bacterial diseases can be obtained, those will probably offer as satisfactory objects for study as could be wished for. The effect which bacteria produce on the plant is usually noticeable after brief periods. Then again pure cultures can be made easily, and these can be subjected to various conditions, to show whether vigor of the parasite has anything to do with the virulency of the disease. The rusts can be used to some extent, particularly after several years, when one has succeeded in establishing barberry plants with aecidia. The species of *Melampsora* and *Puccinia* furnish useful material.

The smuts are very instructive. We have one section of our greenhouse devoted to these, using several grains. These are covered with spores before planting and after several months the new spore crop is obtained. We have not yet tried any of the anthracnoses, probably because of the lack of living material, but they ought to be easy to handle, as pure cultures can so readily be made and kept. One might go on at length with this phase of the study. This is hardly necessary now, for to the live teacher new points of view will present themselves from time to time.

A word ought to be said about insects here, for they destroy plants as much as fungi do. The entomologist has reigned supreme in this field hitherto, probably for the same reason that the systematic mycologist has had charge of the fungus side. The biting insects which injure plants by making wounds have little interest for the pathologist aside from the wounds made. Those insects which form galls, which mine in leaves and stems, or under

the bark of trees, have a decided interest for him, and ought to be alluded to at least in any course of vegetable pathology.

A third phase which I wish to touch upon briefly deals with the influence of environment on the disease-causing factors, particularly the fungi. Many spores of fungi must undergo resting periods of various lengths of time before germinating; others do not ripen until late in the winter. Sclerotia must undergo freezing or a resting period. I believe truly that there are many of us that know positively that the ascospores of *Microsphaera* germinate sometimes and produce patches of mycelium, and that the sclerotia of *Claviceps* form perithecia bearing heads, but how many of us have ever seen these spores germinating, or tested the length of time necessary to do so? We have built a "resting frame" so-called for our fungus friends in the Missouri Botanical Garden, where they lie under leaves, and are disturbed every once in a while, and put under conditions where they might change, side by side with spores or sclerotia kept indoors all the time. Sometimes our spores germinate and sometimes they never do. But even then the student learns the lesson that the spores of fungi have adapted themselves to the peculiar conditions of environment, and will respond only when these are exactly right. Under proper conditions most spores will germinate, and it is a far more instructive lesson to have them do so after repeated failure than to give up the first time. I have always remembered the sad face and drawl of the man in my class at college who said that it was all very nice to study the sections of cluster cups and see mounts of germinating teleutospores and sporidia, but he didn't think they ever did those things outside, if so, why didn't we ever see them.

Therapy, or healing, forms a small part of our study, for with plants the maxim that prevention is better than cure must always hold true. Spraying and other fungicidal methods may properly be experimented with on a small scale, but only with infected plants. With smuts the various seed treatments can be carried out without much trouble, at the same time that smut-infected seeds are planted.

Summing up briefly, I would emphasize the fact that in all the phases of this study the living plant must be kept in the foreground. It goes without saying that the division suggested above

cannot be rigidly maintained, nor is it desirable. The various factors work too closely one with or against the other, but with care, each can be emphasized at the proper time. The theoretical considerations of immunity, the symptoms of disease, the spreading and the nature of disease, must go hand-in-hand with the experimental work, but should at all times be subordinated to it. Questions such as that belong to the end of a course, after the student has thoroughly grasped the meaning of the complex interrelation of plants to each other and their surroundings. Personal acquaintance with one or more diseases, and a careful analysis of each, will lead to a broader conception of disease by itself, and will make a more lasting impression on the student when he must puzzle over these questions on his own account. Nowhere is too much teaching to be deplored more than in experimental work of the kind mentioned above.

Two new Western Mosses

By R. S. Williams

(With Plates 4 and 5)

Eurhynchium Taylorae

Evidently dioicous; no ♂ flowers found. In loose tufts with stout, creeping stems (in places denuded of leaves and with dense tufts of radicles) up to 20 cm. long and 0.44 mm. in diameter; cross sections show a well-defined central strand of numerous small cells and outer wall of about three rows of small thick-walled cells; branches rather short (1 to 2 cm.), irregular and often distant; stem and larger branch leaves loosely spreading, obtusely pointed, the branch leaves often truncate or praemorse at tip, decurrent, serrulate all round to a little above the base, reflexed on margin above and near base and costate about 7/8 up, the costa ending in spine and more or less papillose below; stem leaves measure up to 2.5 × 1.5 mm., middle branch leaves 1.5 mm. and upper branch leaves 0.875 mm. long, the lowest branch leaves very small, roundish and often ecostate; inner perichaetial leaves ecostate or very faintly costate, abruptly narrowed to a slender flexuous serrulate point and irregularly toothed and lacerate at base of point; leaf-cells mostly linear-vermicular, median .004 × .06 to .08 mm., apical very short and irregular, alar forming an elongated not well-defined group of pale cells about .008 mm. wide and two to four times longer, the basal cells somewhat thickened and pitted, especially toward costa; capsule mostly horizontal, contracted more or less under the mouth when dry, without lid 2.5 by 1.5 mm., lid with obliquely rostrate beak 2 mm. long, stout, smooth seta up to 15 mm. high, annulus of two or three rows of cells; peristome teeth very slender-pointed, striate below, papillose above, hyaline bordered, the segments more or less split with mostly two somewhat appendiculate cilia between; stomata roundish, .025 mm. in diameter; spores nearly smooth, up to .014 mm.

In size this plant most nearly approaches *E. Oreganum* of any of our North American species but is less regularly pinnate with smooth seta, etc. It much more closely resembles *E. striatum* of Europe, but is a more creeping plant with less divided stems and leaves never acutely pointed as in that, which also lacks the spine at apex of costa.

Collected by J. B. Leiberg on decaying logs in streams, April, 1889, Traille River Basin, Idaho (172). Named for the artist who has made the excellent drawing which accompanies this description, Miss Alexandrina Taylor.

Brachythecium Pringlei

Monoicous; ♂ flowers abundant on fruiting stems. Growing in compact tufts with ascending, more or less branching stems 4–5 cm. long and 0.25 mm. in diameter; cross sections of stem show a distinct central strand and 3 or 4 rows of thick-walled outer cells; branches mostly short, rather irregular, with curved tips; stems and branch leaves very similar, up to 2.5 × 1.5 mm., secund, mostly broadly ovate with short acute point, long decurrent, concave, scarcely or not plicate, borders flat, entire or slightly serrulate above; leaf-cells somewhat thickened and near base, pitted; median cells linear, about .04 × .005 mm., alar cells mostly about .012 × .016 mm., often forming a distinct convex cluster packed with chlorophyll; inner perichaetial leaves erect, gradually lanceolate-pointed, the point somewhat variable in width, nearly entire and ecostate; seta distinctly papillose in upper part, about 1 cm. high; capsules (not quite mature in only specimens seen) ovate-oblong, not quite symmetrical, nearly erect, with lid 2.5 mm. long; lid highly conical, .8 mm. high; annulus narrow, of 1 or 2 rows of cells; teeth about .430 mm. high and .065 mm. wide at base, rather broadly and irregularly pointed, hyaline bordered, rather irregularly striate and somewhat papillose below, and distinctly papillose above; basilar membrane of endostome extending about two fifth up, segments more or less split, cilia mostly 2 and not appendiculate; stomata slightly elongated, about .025 mm. long; spores (immature) smooth, .015 mm.

This plant with its short-pointed, scarcely plicate and secund leaves with vein sometimes forking, has much the appearance of a *Limnobium* (*Hygrohypnum*), but the seta rough above and the highly conical lid seem to relate it most closely to *Brachythecium*, which also contains all the first-mentioned characters. Collected by C. G. Pringle in the Huachuca Mts., Arizona, July, 1884 (22).

Explanation of Plates

Drawings made with a magnification twice the diameter reproduced on the plates.

PLATE 4

FIG. 1. Plant, natural size.

FIG. 2. Stem leaf, × 15.

FIGS. 3, 4, 5. Lower, middle and upper branch leaf, × 15.

FIG. 6. Alar region of stem leaf, × 120.

FIG. 7. Apex of same, × 120.
FIG. 8. Cross section of costa.
FIG. 9. Part of cross section of stem, × 87.
FIG. 10. Perichaetial leaf, × 15.
FIG. 11. Capsule, × 7.5.
FIG. 12. Stoma, × 210.
FIG. 13. Portion of peristome with annulus, × 120
FIG. 14. Spores, × 120.

PLATE 5

FIG. 1. Plant, natural size.
FIG. 2, 3. Stem leaves, × 15.
FIG. 4. Branch leaf, × 15.
FIG. 5. Alar region of stem leaf, × 120.
FIG. 6. Apex of same, × 120.
FIG. 7. Median cells, × 210.
FIG. 8. Cross section of leaf, × 120.
FIG. 9. Part of cross section of stem, × 120.
FIG. 10. Antheridial bud, × 15.
FIG. 11. Antheridia and paraphyses, × 45.
FIG. 12. Perichaetial leaf, × 17.
FIG. 13. Capsule with upper part of seta.
FIG. 14. Oblique view of seta showing papillae, × 162.
FIG. 15. Stoma, × 210.
FIG. 16. Part of peristome and capsule, × 120.
FIG. 17. Spores, × 120.

New Species of Fungi

By Charles H. Peck

Tricholoma niveipes

Pileus at first hemispherical or very convex, becoming broadly convex or nearly plane, dry, innately fibrillose, almost virgate, dark brown or grayish-brown; flesh white; lamellae rather narrow, close, sinuate, snowy white; stem equal or nearly so, solid or stuffed, snowy white; spores oblong, 7–8 μ long, 3 μ broad.

Pileus 5–12 cm. broad; stem 5–7 cm. long, 6–12 mm. thick.

Sandy soil under or near pine trees. South Yarmouth, Mass. October. S. Davis. The species is allied to *T. terreum* and its variety *fragrans*, from both of which it is separable by its more fibrillose pileus, its closer pure white lamellae and very white stem and by its more narrow spores.

Hygrophorus pallidus

Pileus thin, convex, becoming nearly plane with the margin somewhat decurved and sometimes wavy, glabrous, hygrophanous, pale lilac or mauve and sometimes striatulate on the margin when moist, grayish-white when dry; lamellae rather thick, distant, arcuate, adnate or slightly decurrent, colored nearly like the pileus when moist, subcinereous when dry; stem slender, equal or narrowed downwards, glabrous, hollow, white; spores white, subglobose, 5–6 μ long, 4–5 μ broad.

Pileus 1.5–3 cm. broad; stem 2.5–5 cm. long, 2–4 mm. thick.

Damp, mossy or swampy ground. Mass. September. S. Davis. This is apparently related to such species as *H. sphaerosporus* and *H. Peckii*.

Hygrophorus pusillus

Pileus convex, thin, slightly viscid, glabrous, white; lamellae arcuate, subdistant, decurrent, white; stem short, glabrous, hollow, white, with a white mycelioid tomentum at the base; spores 4–6 μ long.

Pileus 1–2 cm. broad; stem 2–2.5 cm. long, 1–2 mm. thick.

Growing on the ground in dense woods. Moscow Mountains, Idaho. November. L. F. Henderson. The species is apparently related to *H. niveus*, but its pileus is not at all umbilicate, and the

plant has a pleasant anise-like odor. By its hollow stem and smaller spores it is separable from *H. russo-coriaceus*.

· Hygrophorus paludosus

Pileus fleshy, convex, obtuse, covered with a thick yellowish or brownish gluten, whitish; flesh white, taste slightly acrid, odor earthy; lamellae adnate or slightly decurrent, subdistant, whitish, stained with greenish-yellow when old; stem nearly equal, rather long, flexuous, often curved at the base, solid, glutinous, white, with yellowish glandular dots at the top, streaked with brownish fibers or shreds of the dried gluten when dry; spores white, broadly elliptic, 8–10 μ long, 5–7 μ broad.

Pileus 2–4 cm. broad; stem 5–10 cm. long, 4–8 mm. thick.

Growing among peat mosses. Greenville, Mich. September. B. O. Longyear. The species is apparently related to *H. chrysodon*, but its habitat is different, it is a more slender plant, the dots at the top of the stem become black in drying, and there are yellowish stains at the base of the stem.

· Russula pulverulenta

Pileus rather thin, convex, soon centrally depressed or subumbilicate, even on the margin, pulverulent or scurfy, grayish-brown; flesh white, taste disagreeable, odor fetid; lamellae moderately close, adnate, white, the interspaces veiny; stem subequal, thickly beset with yellow dots or granules, white at the top, pallid below; spores globose, 8 μ in diameter.

Pileus 3–5 cm. broad; stem 3–4 cm. long, 8–10 mm. thick.

Woods. Michigan. July. B. O. Longyear.

The relationship of this species is apparently with *R. foetens* and *R. granulata*, from both of which it is very distinct by the yellow pulverulence of the pileus and stem and by the even margin of the pileus.

· Russula ventricosipes

Pileus thin, broadly convex, nearly plane or slightly depressed in the center, glabrous, varying in color from tawny yellow to pale alutaceous; flesh white; lamellae thin, narrow, close, slightly sinuate, adnate, white or whitish, becoming discolored in drying; stem stout, firm, ventricose, solid, or somewhat spongy within, subglabrous, whitish above, reddish toward the pointed base; spores broadly elliptic or subglobose, 6–8 μ long, 6 μ broad.

Pileus 5–7 cm. broad; stem 5–7 cm. long, about 2.5 cm. thick in the middle, more narrow toward each end.

Sandy soil under or near pine trees. South Yarmouth, Mass. October. S. Davis.

A singular species resembling in some respects *Tricholoma compactum*, but apparently a *Russula*. Remarkable for the thin, slightly sinuate lamellae and the stout ventricose stem which seems out of proportion to the small thin pileus.

Cantharellus pulchrifolius

Pileus thin, convex or slightly depressed in the center, glabrous, distantly and obscurely ciliate on the margin, white; lamellae simple, unequal, distant, decurrent, bright yellow; stem nearly equal, glabrous, hollow, white; spores elliptic, 8 μ long, 4–5 μ broad.

Pileus about 1 cm. broad; stem 1–1.5 cm. long, about 1 mm. thick.

Decayed wood. Moscow Mountains, Idaho. October and November. L. F. Henderson.

This is a small but beautiful species. The bright but delicate yellow hymenium, approaching a deep chrome, contrasts prettily with the clear white color of the pileus and stem. The cilia on the margin of the pileus are distant and easily overlooked. The lamellae are unbranched but a few short ones intervene.

Marasmius tomentosipes

Pileus thin, convex, becoming nearly plane, generally umbilicate, glabrous, widely striate on the margin when moist, brownish yellow or ferruginous, becoming brown with age; lamellae thin, subdistant, unequal, arcuate, decurrent, pale yellow, interspaces venose; stem slender, tough, elastic, hollow, blackish-brown, covered with a tawny tomentum which is more dense and matted at the base; spores elliptic, 6–7 μ long, 3–4 μ broad.

Pileus 1–3.5 cm. broad; stem 2–4 cm. long, about 1 mm. thick.

Vegetable mold in damp mossy places in coniferous woods. Moscow, Idaho. December. L. F. Henderson.

This species bears a close resemblance to *Omphalia campanella* and might easily be mistaken for it if the tomentum of the stem is overlooked. This is sometimes collected in minute tufts which to the naked eye give a pulverulent appearance to the surface of the stem. The plants revive under the influence of moisture.

Lentinus Americanus

Pileus thin, convex, nearly plane, centrally depressed or subinfundibuliform, glabrous, irregular or lobed on the margin, pallid; lamellae moderately close, dentate and lacerate on the edge, slightly decurrent, whitish; stem short, nearly equal, even, solid, brown with a reddish-brown strigose villosity toward the base; spores broadly elliptic or subglobose, 6 μ long, 5–6 μ broad.

Pileus 2–2.5 cm. broad; stem 1–1.5 cm. long, 2–4 mm. thick.

Growing singly or in tufts, rarely on rotten logs, commonly on the ground in moist shady thickets. Volmer, Idaho. L. F. Henderson.

The stem is sometimes eccentric but it is not at all sulcate. The plants have a delicate odor resembling that of apricots and an agreeable taste.

Entoloma nigricans

Pileus thin, convex, becoming irregularly expanded and centrally depressed, innately silky fibrillose, shining, dark gray or blackish, the cuticle often radiately cracking, inodorous; lamellae broad, subdistant, sinuate, adnate, salmon color; stem equal, silky fibrillose, at first solid, becoming hollow, shining, white streaked with black, sometimes scurfy at the top; spores salmon color, angular, uninucleate, 8–12 μ long, nearly as broad.

Pileus 2.5–4 cm. broad; stem 2.5–5 cm. long, 4–8 mm. thick.

Woods in low ground. Near St. Louis, Mo. October. N. M. Glatfeldter. In the dried specimens the margin of the pileus is somewhat striate or sulcate, but the pileus is not striate when fresh nor is it hygrophanous.

Locellina Starnesii

Pileus fleshy but thin, convex or nearly plane, somewhat umbonate, white with a sepia brown center from which radiate brown streaks or lines intermingled with minute brown spots or dots; flesh white; lamellae narrow, close, free, concealed when young by the membranaceous white veil, pink or rosy tinted, becoming cinereous brown with age; stem slender, often curved, sometimes straight, stuffed with a small pith, white, ending below in a cup-like bulb; annulus superior, often torn and adhering partly to the stem and partly to the margin of the pileus; spores brown, elliptic, 5–6 μ long, 4 μ broad.

Pileus 2.5–5 cm. broad; stem 2.5–5 cm. long, about 4 mm. thick.

Bath, Georgia. October. V. Starnes.

So far as known to me, this is the first representative of this genus found in our country. I find no description to match it and take great pleasure in dedicating it to its discoverer.

Agaricus Sterlingii

Pileus fleshy, firm, convex or sometimes slightly depressed in the center, slightly silky and sometimes with appressed spot-like scales in the center, pale brown or grayish-brown; flesh dingy, white or brownish; lamellae thin, close, free, pale brown, becoming blackish-brown with age; stem equal or nearly so, solid or stuffed, whitish, sometimes darker above the annulus; veil thick, partly adhering to the margin of the pileus and partly to the stem; spores broadly elliptic, 6–8 μ long, 4 μ broad.

Pileus 5–12 cm. broad; stem about 2.5 cm. long, 8–12 mm. thick.

Cespitose. December and April. New Jersey. E. B. Sterling.

This is one of the few species of the genus *Agaricus* in which the lamellae show no pinkish hues in any stage of development. Even in the young plant they have a light sepia tint which becomes darker with age. This mushroom is edible and is regarded by the two families who have eaten it freely, as richer in flavor than the common mushroom. It seems to be more productive and less quickly perishable. Specimens were sent me by Mr. Sterling to whom the species is dedicated.

Clavaria grandis

Stem stout, distinct, radicating, divided above into numerous long erect or slightly diverging branches which are repeatedly branched, solid but very fragile, glabrous, reddish-brown with white tips at first, becoming somewhat pulverulent and ferruginous brown with concolorous tips when old, somewhat fragrant; spores ferruginous, broadly elliptic or subglobose, distinctly verrucose, 10–12 μ long, 6–8 μ broad.

Plant 12–20 cm. high, nearly as broad above; stem 2–2.5 cm. thick.

Thin woods under *Smilax* bushes. Maryland. September. F. J. Braendle.

According to Mr. Braendle this large *Clavaria* is edible when prepared as pickles and put up in spiced vinegar.

HELVELLA MACROPUS **brevis** var. nov.

Cups small, 8–16 mm. broad; hymenium black or nearly so; stem short, 8–16 mm. long; spores uninucleate.

Massachusetts. G. E. Morris.

The small size, darker hymenium and very short stem, which is scarcely more than half an inch long, are the distinguishing characters of this variety. A conglobated mass of earth adheres to the bottom of the stem which thereby appears at first sight to be bulbous.

Some new Species of Californian Plants

By Alice Eastwood

(With Plates 6 and 7)

Fritillaria Purdyi (Plate 6)

Corm with fibrous roots, deep-seated, with a large bublet on one side and a very small one on the other; stem flexuous, enlarged below the leaves, extending underground 15 cm.: radical leaves opposite but apparently whorled in 3 pairs, thick, pale green, oblong-lanceolate; the outer 3 cm. broad, 9 cm. long; the inner about half as broad and of almost equal length; margin strongly undulate, crisped along the very edge; cauline leaves 4, alternate, lanceolate, obtuse or callous-tipped: flowers 1–2, 2.5 cm. long, white, mottled with purple in lines and spots, on erect pedicels that recurve at apex; outer divisions obovate, 13 mm. wide, slightly incurved at base, the middle marked by a greenish-yellow band which later becomes purple; inner divisions oblong-lanceolate, as long as the outer but narrower, 8 mm. wide: stamens with versatile anthers, filaments 1 cm. long: ovary 6-ribbed, cylindrical, 5 mm. long, spotted with purple, tipped by the style, which is 2 mm. long: fruit purplish, obconic-orbicular, obtusely 6-sided, each side being marked by a prominent nerve but without wings or ribs, abruptly tapering at base, flat on top, about 15 mm. long: seeds somewhat thickened on one side, winged on the opposite side, 6 mm. long.

This description was drawn from fresh specimens sent by Carl Purdy in whose honor it is named. The specimens were grown in Mr. Purdy's garden in Ukiah from bulbs sent by Mr. Charles Lowe from Kneeland, Humboldt county, California. It was blooming in April in Mr. Purdy's garden and the ripe fruit was sent to me by Mr. Lowe, May 27. He collected it where he had collected the original bulbs. Mr. Lowe also sent blooming plants in April which were not so tall nor so luxuriant as those from which the description was made. The type is in the herbarium of the California Academy of Sciences. The drawing, from the fresh specimen, was made by Miss Margaret W. Buck.

Monotropa Californica (Plate 7)

Stems solitary or in clumps, about 1 dm. high, glabrous, waxy-white: leaves deltoid to ovate, sessile by a broad base, acute, entire or slightly erose, 1–2 cm. long, about 6 mm. wide at base: flowers

in a densely-flowered erect spike, terminating the erect stem, containing about 15 flowers; bracts similar to the leaves, but narrower, the upper ones becoming spatulate with broad, short petioles; terminal flower first in bloom, with 5 petals and sepals and 10 stamens; lower flowers with 4 petals, 2–4 sepals and 8 stamens: sepals rhomboidal oblanceolate or linear, keeled, the blade when present about as long as the claw, altogether 12 mm. long, 2–4 mm. wide, margin slightly erose, outer surface glabrous, inner sparingly hairy: petals oblong-obovate, 12 mm. long, 4 mm. wide, densely hairy within, saccate at base, the sac containing nectar, lower margin ciliate, upper erose and sometimes slightly cleft on one side: stamens linear, ribbon-like, woolly, most densely so under the anthers, alternately long and short, 6–7 mm. long, .5 mm. wide, without any dilation at base; anthers bright red, shaped like a strawberry, opening by two equal slits on each side; pollen white: ovary 4–5-lobed, with each lobe obtusely 2-ribbed; style thick, as long as the ovary, densely woolly, especially below the yellow depressed-capitate stigma which is hairy at the center and around the viscid yellow outer rim.

The entire plant, except the red anthers and yellow stigma, is pure white and without any odor, except an earthy smell like a fungus.

Its erect habit at once distinguishes it from *Monotropa Hypopitys* to which it is most closely allied. The stamens seem different from those of other species of *Monotropa*, judging by the figures and descriptions. These were probably made from dried specimens and perhaps from stamens from which the pollen had been discharged.

This species was found on a hillside bordering Little Carson Creek, in Marin county, California. The hill was covered with a dense growth of small trees of *Quercus densiflora*. *Clintonia Andrewsiana* was abundant and occasional specimens of *Coralorhiza Bigelovii* and *C. multiflora* were found near by. The first specimen (in bud) was found on May 12th. This was a solitary plant. On May 30th a clump of five plants was found in the same neighborhood, but no more have been seen though searched for diligently.

Unless the anthers are peculiar, this belongs to the section *Hypopitys*, which is considered a distinct genus by some botanists.

Type in the herbarium of the California Academy of Sciences.

Cycladenia venusta

Stems low, 1–1.5 dm. high, several from a horizontal woody rootstock, glaucous and glabrous throughout except the flowers: lowest leaves scale-like; the others broadly ovate to orbicular, 2–6 cm. in diameter, coriaceous, prominently nerved; apex obtuse, acute, or abruptly acuminate; base broadly cordate or cuneate; margin entire or slightly undulate; petioles broad, flat, longer than the blades on the lower leaves, shorter on the upper, connate-clasping: flowers in axillary corymbs, 3–7-flowered; peduncles rather stout, generally shorter than the leaves; pedicels less than half as thick, glabrous or sparingly pubescent, 1.5–3 cm. long; bracts ovate-acuminate, glabrous externally, with a few scattered hairs within and on the margins, about 5 mm. long: divisions of the calyx extending almost to the base, linear-lanceolate, 5 mm. long, 1 mm. broad, clothed on both sides with scattered, spreading hairs: corolla funnel-form, with tube slightly shorter than the calyx, limb almost 2 cm. long, lobed about half way with five equal orbicular-oblong lobes, 7 mm. in diameter, bright rose-color, hairy externally, especially on the tube, somewhat pubescent within and viscid: stamens with short, hairy filaments, inserted at the top of the tube on the ribs; anthers sagittate with the apex and tips cuspidate: stigma as in the genus: follicles glabrous and glaucous, immature, 4 cm. long.

This beautiful species was first collected by the writer on the summit of Santa Lucia Peak, in Monterey county, California, June 9, 1893. It was collected by Mr. R. A. Plaskett on Cone Peak in the same range of mountains in fruit in 1898.

It differs from *Cycladenia humilis* Benth. in the shape of the leaves, much larger flowers, corolla with shorter tube and more open-campanulate border, and the pubescence of the flowers.

Type in the herbarium of the California Academy of Sciences.

Potentilla Hickmani

Perennial from a woody tap-root; the caudex densely clothed with the brown, dry stipules and petioles; stems low, decumbent, 8–15 cm. high, sparingly clothed with appressed hairs: leaves mostly radical, with generally six pairs of rather distant, petiolulate leaflets; these cuneate, digitately 3–4-cleft or divided, with linear or lanceolate divisions, 2–8 mm. long, 1–3 mm. wide, veiny, glabrous or with a few scattered hairs on the upper surface, more densely appressed-hairy on the lower; stipules attached to the petiole, the free portion linear-acuminate, about 5 mm. long; cau-

line leaves few and distant, with large, obliquely ovate stipules which are adnate to the petiole up to the blade; these are similar in form to the leaflets but larger: cyme with 2–4 branches, each 1–2-flowered: calyx clothed with appressed pubescence, more densely so at base; divisions ovate, obtuse, 6 mm. long, 3.5 mm. wide: bractlets ⅓ as long, ovate: petals yellow, 6 mm. long, 5 mm. wide, cordate with shallow sinus: receptacle white-hairy: filaments narrowly subulate, 2 mm. long: style slender, attached to the akene a little below the apex, glabrous, 3 mm. long: akene glabrous, gibbous.

This seems to come nearest to *Potentilla Plattensis* Nutt., from which it differs in having larger flowers, with obtuse calyx lobes and bractlets and digitately cleft leaflets less imbricated. The broad stipules are noticeable on the cauline leaves, those on the radical leaves being much narrower.

This was collected in a forest of *Pinus radiata* Don., near the reservoir which supplies Pacific Grove, California, along the road to Cypress Point, April 4, 1900. It is named in honor of Mr. J. B. Hickman who has collected many interesting plants in Monterey county and who was my guide on the trip on which this was collected.

Type in the herbarium of the California Academy of Sciences.

Orthocarpus psittacinus

Perennial, stems several from a branched caudex, generally also branching above, 1.5–2 dm. high, striate, pilose with spreading white hairs: lower leaves linear, entire, 2–6 cm. long; upper ones broader, 3–5-cleft near the apex into linear lobes, the middle lobe longest; floral leaves broader, the middle lobe generally irregularly 2–5-cleft, the ultimate division often broadening at the apex, greenish-yellow, surpassing the flowers: calyx with membranous tube enclosing the corolla and with four lanceolate-filiform divisions, equal or unequal, extending below to the ovary and above to the throat of the corolla, greenish-yellow: corolla the same color, 2 cm. long; upper lip straight, slightly surpassing the lower, obtuse; lower lip 3-cleft with oblong, obtuse divisions, 2 mm. long, plicate below: stamens with glabrous filaments and 2-celled anthers, the cells unequal: style exserted; stigma capitate; ovary acute, minutely papillose: seeds 1 mm. long, the outer coat membranous, deeply pitted.

This is probably one of the forms included under *Orthocarpus pilosus* Watson. The leaves are not divaricately lobed as in that

species, the divisions of the calyx are equally cleft and much narrower, the corolla is longer with the divisions more nearly equal in length, and the seeds are more membranous and more deeply pitted. I have compared it with specimens of *O. pilosus* collected near Lake Tahoe and Summit Station on the C. P. R. R. This is in the same region as the original collection, Washoe county, Nevada.

This species came from Warner Mountains, Oregon and was collected by Mrs. Bruce, July, 1898 (no. 2240).

Type in the herbarium of the California Academy of Sciences.

Spraguea pulchella

Apparently annual, low, with slender decumbent stems, glabrous throughout: radical leaves spatulate on long margined petioles, longer than the blades, together 5–20 mm., purplish, entire, obtuse; cauline leaves of two kinds, one like the radical leaves but smaller, the others bract-like: flowers in scorpioid subcapitate spikes, closely imbricated, at the ends of slender divaricately spreading branches; pedicels short; bractlets broadly ovate-cordate, rose-color, membranous: sepals somewhat unequal, orbicular, emarginate at apex, reniform at base, rose-color with darker or somewhat greenish stripe down the middle, 3 mm. in diameter: petals 4, oblong to linear, acute, thin, veiny, conniving over the ovary after anthesis, slightly over 2 mm. long: filaments about as long as the petals, filiform: anthers elliptical, .5 mm. long, yellow, not exserted: style long and slender, the two-cleft apex surpassing the corolla: ovary with 1–2 ovules on slender funiculi: seeds the same number, showing through the diaphanous walls of the orbicular capsule, brown when ripe.

This comes nearest to *Calyptridium monospermum* Greene. It differs in the shape of the sepals and petals, in having invariably not more than two ovules, while *C. monospermum* has from one to several, ripening 1 or 2 seeds. The panicle is more open and the entire plant more slender and delicate. My specimens were compared with the duplicate of the type, no. 2135 of the Death Valley Expedition, collected in Big Cottonwood Meadows by F. W. Koch. It was kindly loaned me by F. V. Coville, Chief of the Division of Botany, Department of Agriculture, Washington, D. C.

This species was collected by Mr. J. W. Congdon near Pea Ridge road, Mariposa county, California, April 19, 1901.

Type in the herbarium of the California Academy of Sciences.

Sidalcea rostrata

Perennial from a rather short horizontal rootstock which is generally conspicuously verrucose with the old axillary buds: stem erect, 3 to 4 dm. high, sparingly hispid with simple forked or stellate spreading or irregularly appressed hairs, obtusely angled: leaves strongly nerved, pubescence as on the stem but more abundant, especially on the petioles; radical leaves orbicular reniform, 5 cm. broad, crenate with every alternate sinus deeper, on ribbed petioles 6 to 15 cm. long; cauline leaves similar in outline, on shorter petioles, diminishing upwards, 7-lobed, the lobes again lobed or deeply crenate-dentate; stipules ovate-lanceolate, 5 mm. long, soon deciduous: inflorescence racemose-spicate, of about 16 flowers: lower bracts 5-parted into lanceolate divisions, surpassing the calyx, upper ones becoming more simple and smaller, not equalling the calyx: pedicels 5 to 10 mm. long: calyx open-campanulate, deeply parted into 5 deltoid-acuminate divisions about 1 cm. long, densely hispid externally with conspicuous spreading hairs, tomentose within at the apex and along the margin: petals rose-purple, obovate, 2.2 cm. long, 1.8 cm. wide, glabrous, veiny, densely ciliate at base above the broad short claw, deeply emarginate or cordate at apex with margin somewhat erose: stamineal column double, hispid: phalanges distinct, the outer less divided than the inner: anthers dark purple, papillose: carpels (immature) 8, sparingly pubescent, conspicuously rostrate with the yellowish beak densely hispid.

This was collected by H. E. Brown near Mendocino, California, June, 1898 (no. 815).

Type in the herbarium of the California Academy of Sciences.

This species belongs to the group of closely allied species where *Sidalcea malvaeflora* Moc. & Sess., is found. The carpels are, however, quite unlike those of any other species of the group and would be sufficient to mark it as distinct were it not for the other characteristic features.

Stachys flaccida

Perennial, from running rootstocks: stems stout, hollow, erect, about 10 dm. high, nearly glabrous below except for the pustulate retrorse bristles on the four prominent angles: leaves ovate-cordate, acute at apex, crenate, thin and flaccid, 10–13 cm. long, 5–8 cm. wide, woolly pubescent on the lower surface with irregularly appressed iridescent, fine white hairs, the pubescence on the upper surface more regularly appressed but less dense; petioles

equalling or a little shorter than the blades, broad, flat, nerved, densely ciliate, clasping the stem and forming conspicuous nodes: spike leafy at base, about 15 cm. long, the leaves diminishing to linear-oblong bracts; peduncles densely glandular-villous; verticels 1–3 cm. apart, generally 4-flowered: calyx villous-pubescent and glandular, obliquely 2-lipped on pedicels, 1.5 mm. long; divisions deltoid, aristate, 3-nerved, about 9 mm. long, the two lower divisions somewhat shorter than the three upper, all shorter than the campanulate tube: corolla rose-color; tube 2 cm. long, villous-arachnoid; upper lip glandular-villous, rounded or truncate, about half as long as the lower lip; lower lip 3-lobed, the middle lobe hooded, surpassing the auriculate lateral lobes and hoary within: stamens inserted on the throat; filaments flattened, bearded, not exserted: divisions of the stigma equal; styles shorter than the filaments: nutlets immature.

This is nearest to *Stachys Chamissonis* F. & M. (Linnaea, Suppl., 6: 80), of which it might be considered a variety. The flaccid foliage and smaller flowers are more suggestive of *S. ciliata* but the leaves are not acuminate as in that species. It appears to be an intermediate form for which at present a specific name seems better than a varietal, applied to either species. The type locality of *S. Chamissonis* is not given but it was collected by Chamisso and probably some place not far from San Francisco. Compared with specimens collected at Lake Merced near San Francisco this differs, besides in regard to the characteristics mentioned above, in having longer petioles and much more scanty pubescence.

This was collected by H. E. Brown near Mendocino, California, May, 1898. It is no. 836 of his collection. Type in the herbarium of the California Academy of Sciences.

Trifolium tenerum

Perennial, matted-caespitose, from running rootstocks, canescent and softly villous throughout with fine white loosely-spreading hairs: leaves, in general, longer than the internodes; petioles filiform, about as long as the leaflets; these 3, narrowly elliptical to oblanceolate, 5–10 mm. long, 1–2 mm. wide, aristate-acuminate; margin setosely serrulate; surface with conspicuous veins, terminating in the marginal setae, the lower more pilose than the upper; stipules 8 mm. long, adnate for more than one half their length; lower part scarious, veiny; the free upper portion green, subulate-aristate, serrulate: heads few-flowered (1–6), on filiform peduncles which are shorter or longer than the leaves;

involucre glabrous, very small, of 2–5 separate, laciniate-aristate bracts, 2–4 mm. long: flowers 1 cm. or so long, on pedicels less than 1 mm. long: calyx open-campanulate, with subulate aristate divisions a little longer than the tube; tube membranous between the strong veins: corolla long and slender; banner with 3 rounded teeth at the truncate apex; wings slender, as long as the banner, auriculate at base of blade; keel two thirds as long, tipped with an obtuse erect beak, the keel itself purple, auricled at base: ovary obovate, pilose at summit, 1-ovuled.

This seems to be the nearest to *T. pauciflorum* Nutt. from which it differs in habit, pubescence, leaves, flowers, ovary, etc.

It is one of the clovers which carpet the ground in the higher meadows on the trail to the south fork of King's River. It was collected by the writer at Summit and Bearskin Meadows, July 1–13, 1899. The first named specimens are considered the type specimens. Type in the herbarium of the California Academy of Sciences.

Explanation of Plates

PLATE 6. *Fritillaria Purdyi* Eastwood

1. Plant, natural size. 2. The bulb and roots. 3. The perianth spread out. 4. An outer division of the perianth. 5. The ripe capsule. (All natural size.)

PLATE 7. *Monotropa Californica* Eastwood

1. A single stem, natural size. 2, 3. Sepals. 4. Petals. 5. Pistil. 6. Front view of anther before it opens. 7. Back view of same. 8. Anther discharging pollen. 9. Appearance after the pollen has been discharged. The parts of the flowers are all enlarged five times.

Supplementary Notes on the Erysiphaceae

By Ernest S. Salmon, F.L.S.

(Continued from page 22)

Podosphaera oxyacanthae (DC.) de Bary. (Monograph, p. 29)

Syn. add: *P. clandestina* Lév. var. *ramulicola* Thüm. Bull. Soc. Imp. Nat. Mosc. 56[2]: 126. 1882.

Exsicc. add:* Shear, New York Fungi, 138 (in herb. Jaczewski),

Distrib. add: Asia; Siberia (Minussinsk).

Hosts, add: *Crataegus nigra* (40), *C. sanguinea*, *C. tanacetifolius* (80), *Prunus Persica* (2*) (40*), *Vaccinium Vitis-Idaca.*

Professor N. Martianoff has kindly sent me a specimen of the *Podosphaera* on which Thümen founded his "*P. clandestina* var. *ramulicola.*" Thümen gave the following diagnosis: "Peritheciis dense aggregatis, numerosissimis, pulviniformibus; mycelio candido, non evanido; ascis sporisque typicis. In ramulis vivis *Crataegi sanguineae* Pall. in sylvis prope Minussinsk." The specimen is remarkable for the manner in which the perithecia are densely compacted in extended patches along the branch of the *Crataegus.* Due probably to this dense crowding, causing lateral pressure, some of the perithecia are oblong-pyriform in shape. The structure of the perithecium, the asci and spores are normal for the species. The perithecia are not fully mature, but the apices of the appendages show the beginning of the characteristic branching of *P. oxyacanthae.* On the whole, I consider that Thümen's plant, being characterized merely by the crowded habit of the perithecia is to be regarded as only a form, and not as a true variety, of *P. oxyacanthae.*

Examples of *P. oxyacanthae* with quite the same habit as that of the "var. *ramulicola*" are seen in the specimen in Ellis and Everhart's N. Amer. Fungi, no. 2335, "on leaves of *Crataegus,*

* Only those exsiccati are quoted which have been personally examined, and unless prefixed by an asterisk, or followed by information as to the source, all the numbers refer to the copies in the Kew Herbarium. Those distinguished by an asterisk are to be found in the herbarium of the British Museum (Natural History), London.

London, Canada, July, 1889 (J. Dearness)." These specimens show further the manner in which this form passes gradually into the type: perithecia with a normal habit occur on both sides of the leaves; on the under side of the leaves about the midrib, we find perithecia congregated in patches with persistent mycelium; and on the branches themselves the perithecia are crowded into dense patches among persistent mycelium.

Other examples of *P. oxyacanthae* occur in the United States —on *Crataegus punctata* and other species of *Crataegus*, on *Prunus Virginiana*, etc.—in which the perithecia are densely crowded along the midrib of the leaf (although the aggregation is not quite so marked as in Thümen's plant), and in these cases it is to be noted that the mycelium is subpersistent in exactly the same manner as in "var. *ramulicola*." It may be observed that among the forms of *Sphaerotheca humuli* the plant on *Neillia opulifolia*, etc. (see monograph, p. 63), stands in the same relation to the type as the "var. *ramulicola*" does not typical *P. oxyacanthae*.

In a specimen of *P. oxyacanthae* on *Crataegus oxyacantha* from "Belluno, Italy (Speg. 7/10 '78)," the spores according to drawings by Spegazzini which are reproduced at *Pl. 9, f. 22*,* are very strongly curved. In the specimen sent to me I was unfortunately unable to find any mature perithecia containing spores. The almost allantoid shape of the spores shown in Spegazzini's drawings is certainly remarkable; although in *P. oxyacanthae* var. *tridactyla* I have observed that the spores are sometimes slightly curved, and in *Erysiphe trina* Harkn., the curving is more frequent and more pronounced.

In another specimen of *Spegazzini's* collecting, from the same locality and on the same host, the appendages reach from 2½ to nearly 3 times the diameter of the perithecium. Such cases as these show clearly the impossibility of keeping the *P. myrtillina* of Kunze and Schmidt apart from *P. oxyacanthae*. (See monograph, p. 32.)

Bailey (**2****) refers the fungus known commonly in the United States as the "peach mildew" to the present species, and observes: "the peach mildew (*P. oxyacanthae*) has been serious in various parts of western New York the past season. In the Niagara belt

* The plates will appear with the final part in the BULLETIN for March.

it has attacked Crawfords, and upon Seneca lake I have seen a peach known as the Denton almost ruined by it. The fungus generally appears when the peach is very small, as irregular mouldy or frost-like patches upon the surface. Later on, these patches become brown and hard, and the peach cracks. The same mildew also attacks the leaves, covering them with a whitish mould-like substance and causing them to become hard and curled."

Waite (Ann. Rep. Dept. Agric. for 1888: 353. 1889) also observes that *P. oxyacanthae* causes considerable harm to the peach. Other writers, however, state that the peach mildew is *Sphaerotheca pannosa* (see p. 92).

P. OXYACANTHAE TRIDACTYLA (Wallr.) Salm. (Monograph, p. 36)

Hosts, add: Prunus Grayana, Pyrus Aucuparia (18).

Distrib. add: Tasmania (62).

Professor Shotaro Hori has sent me the present plant on the leaves of *Prunus Grayana* from Mt. Isukuba, Japan (coll. T. Nishida, Nov. 1900). This is the second record of the var. *tridactyla* from Japan, the fungus in the first case having occurred on *Prunus communis*. The present form on *P. Grayana*, although clearly referable to the var. *tridactyla*, slightly approaches the type in the tendency shown by the appendages of many of the perithecia to diverge somewhat instead of being erect. The apex of the appendages frequently shows the elongated primary branches characteristic of the var. *tridactyla* (see monograph, pp. 110, 111).

Bubak has recorded (9) the occurrence in Bohemia of "*P. tridactyla* De By." on the leaves of *Potentilla reptans*. Dr. Bubak informed me that the specimens have unfortunately been lost. It is most unlikely that the *Potentilla* was here really serving as a host-plant; probably, if the fungus was correctly determined, the perithecia of the *Podosphaera* were merely accidentally adhering to the *Potentilla* leaves (see monograph, p. 23, for similar cases).

P. BIUNCINATA Cooke & Peck. (Monograph, p. 39)

Exsicc. add: * Rehm, Ascomycet. 1100; Shear, New York Fungi 139 (in herb. Jaczewski).

P. LEUCOTRICHA (Ell. & Everh.) Salm. (Monograph, p. 40)

Ref. add: *Sphaerotheca mali* Burr.; Lüstner, Mitteil. über Obst und Gartenbau, **16**: 82 *pl.* 1901.

Distrib. add: N. America, U. S., New York (57).

Hosts, add: *Pyrus communis.*

Lüstner (**42**) gives an interesting account, accompanied by good figures, of the occurrence of the present species on both the leaves and fruit of pear trees in a nursery at Geisenheim, Germany, where it was the cause of some injury to the trees. Hitherto *P. leucotricha* has been known only on the apple in Europe and the United States, and on *Pyrus Sieboldi* in Japan.

P. leucotricha appears to be on the increase in Germany, where there have been numerous reports of late of serious injury caused by this fungus to apple orchards. Bordeaux mixture has been found to be ineffectual as a fungicide, but sulphur is stated to give good results (see Wehmer **86**, **87**, and Magnus **44**, **45**, **46**). Cutting off and burning the affected shoots is, however, a far better method of dealing with the disease than spraying, as, unless this method is adopted, the present fungus, like the "peach mildew" (see p. 92), is liable to recur year after year on the same trees. (See Schlichting **72** *).

The mildew that frequently attacks the young shoots of apple trees in England and in severe cases spreads on to the apples themselves, covering them with a white powdery film, in all probability belongs to the present species, although up to the present I have not seen any perithecia from a British locality.

Goethe (**21**) has recorded the occurrence of *Sphaerotheca pannosa* on apple trees at Geisenheim in Germany; according to specimens (now in the Kew Herbarium), however, sent to me by Dr. Lüstner, the fungus in question is *P. leucotricha.*

Despeissis (**15***) records a fungus as the "Apple and Pear Powdery Mildew (*Podosphaera* sp.)," from western Australia, and remarks: "This disease, which from its appearance at a later stage, is also known as 'Fire Blight,' is more widespread in some seasons than others. It affects the young shoots of pear and apple trees and stunts their growth."

SPHAEROTHECA HUMULI (DC.) Burr. (Monograph, p. 45)

Syn. add: *Torula epilobii* Corda, Ic. Fung. **4**: 23. *pl. 6. f. 75.* 1840.

Oospora epilobii (Cord.) Sacc. & Vogl.; Sacc. Syll. Fung. **4**: 12. 1886.

Oidium fragariae Harz. in Bot. Centralbl. **32**: 314. 1887; Sacc. Syll. Fung. **10**: 520. 1892.

Exsicc. add: *Rehm. Ascomycet. 1349 a; Shear, New York Fungi, 136 (in herb. Jaczewski); Krieg. Fung. saxon. 1212, 1215 (in herb. Jaczewski).

Distrib. add: Europe: Bulgaria (10), Faeröe Islands (63).

Asia: Turkey (Bithynia, in reg. infer. montis Keschisch-dagh (Olympi), supra Brussa (2–300 m. s. m.). 1899. (J. Bornmüller, Iter Anatol. tert. no. 2065)!

Siberia; Poseka, Lusino (Sacc. Malpighia, **10**: 269. 1896).

Hosts, add: Alchemilla Helvetica, Epilobium obscurum (40), *Fragaria* sp. (cult.), *Geranium dissectum, Geum rivale, Potentilla collina* (40), *P. Sibbaldi* (40), *Rubus Idaeus* (Burrill; Ell. & Everh., N. Amer. Pyren. 6), *R. villosus, Tragopogon pratensis* (40), *Veronica Virginica Sibirica.*

Among the specimens of Erysiphaceae sent to me by Professor Kingo Miyabe, there occurs a *Sphaerotheca* on *Veronica* which must be referred to the *S. humuli* type. This occurrence is specially interesting on account of the fact that up to the present only the var. *fuliginea* of *S. humuli* has been known on species of *Veronica.* In Europe, Siberia and Asia, and North America *S. humuli fuliginea* occurs on *Veronica Virginica* (Rab.-Wint. Fung. Eur. 3657, from Missouri, U. S. A., *sub S. Castagnei* Lév.); on *V. spicata* (Roumeg. Fung. gall. exsicc. 2741, from Rouen, France, *sub S. Castagnei* Lév.); on *V. longifolia* (Syd. Myc. March. 1239, from Berlin, Germany, *sub S. Castagnei* Lév.), (Rab. Fung. Eur. 2026, from Saxony, *sub Erysiphe Castagnei* forma *veronicarum*), (de Thüm. Myc. univ. 1839, from Minnussinsk, Siberia, occid., *sub S. Castagnei* Lév.). In all the above-cited examples the fungus is typical *S. humuli fuliginea,* with perithecia measuring from 60–70 μ in diameter, and the cells of the outer perithecial wall, averaging 25 μ wide. The Japanese plant, of which two examples have been sent—"on the skins of *Veronica Virginica*

var. *Sibirica*, Sapporo, Sept. 17, 1890, coll. E. Tokubuchi," and "on the leaves of *V. Sibirica*, Sapporo, Oct. 10, 1894, coll. N. Hiratsuka," belongs, as mentioned above, to the *S. humuli* type. The perithecia measure about 100 μ in diameter, and the cells of the outer wall average 15 μ wide. *V. Sibirica* is treated by most botanists as synonymous with *V. Virginica*.

Corda's figures of his "*Torula epilobii*" well represent the conidial (*Oidium*) stage of *S. humuli*, which occurs not uncommonly on species of *Epilobium*. Saccardo has transferred Corda's *Torula epilobii* to the genus *Oospora*—evidently by a slip, as in the key to the genera of the *Hyphomycetes* (Saccardo, Syll. **4**: 3) *Oospora* is placed in the section comprising genera which contain "species saprophilae," and Corda expressly described his plant as parasitic.

During the season 1900 *S. humuli* was the cause of the destruction of the strawberry crop in many districts of England. The fungus, in its conidial stage—to which the name *Oidium fragariae* Harz has been given on the Continent—spreads from the leaves of the strawberry plant to the fruit, investing it with a white powder, and ruining it for market purposes. I have already (**71** and **72**) given an account of this outbreak of the "strawberry mildew," with notes as to the varieties which are most attacked and those which appear to be immune. The fungicide which was found to be most effective was prepared in the following manner: one ounce of carbonate of copper is mixed with 5 ounces of carbonate of ammonia, and dissolved in a quart of hot water; when dissolved 16 gallons of water are added. The plants should be sprayed repeatedly with this fungicide as soon as any trace of the mildew appears on the leaves, for it has been found that once the fungus is in full vigor on the fruit nothing can be done to save the crop.

Professor McAlpine reports from Australia that during 1901 strawberry plants were very severely attacked by a "strawberry *Oidium*," and that although the strawberry plants were carefully examined at the end of winter, no perithecial stage could be found.

The disease known to hop-farmers under the name of "red mould" is probably caused, as Hammond (**24**) has pointed out, by *S. humuli*. In hops attacked by "red mould" the bracts of the cones lose their normal bright yellowish-green color, and become tinged reddish-brown. Other writers, however, have stated that

this reddish color is due to the incipient death of cells caused by certain atmospheric conditions, excessive dryness of soil, etc., and consider that the fact of the red color being sometimes present in hops which show no trace of the *Sphaerotheca* affords conclusive proof that "red mould" is not caused by the present fungus. I have, however, found in studying the "strawberry mildew" disease, caused by *S. humuli*, that strawberry leaves may commonly be found (after the disease has been running for some time) on which no trace of any fungus is to be found, yet which bear reddish discolored patches on the under surface. Continuous observation of diseased strawberry plants showed that these reddish patches were composed of epidermal cells which had been killed or whose contents had been modified, by the haustoria of *S. humuli*, and that the mycelium after causing this injury, had completely disappeared.

S. HUMULI FULIGINEA (Schlecht.) Salm. (Monograph, p. 49)

Syn. add: *S. microcarpa* Hazslinszky, M. Tud. Akad. Math. ès Természettud. Közlemények, **15**: 20. 1878. *S. phtheirospermi* P. Henn. & Shirai, Engler's Bot. Jahrb. **29**: 147. 1900. *S. fuscata* (B. & C.) Serbinov. Scripta Bot. Univ. Petropol. **18**: (16). 1901.

Exsicc. add: Krieger, Fung. saxon. 1210, 1211, 1213, 1214, (in herb. Jaczewski); Rehm, Ascomycet. 1349b; Shear, New York Fungi, 137 (in herb. Jaczewski).

Distrib. add: Europe, Bulgaria (10); Asia, Siberia, Yeniseisk, "flum. Yenisei inter 58° et 71°" (A. Kitmanoff).

Hosts, add: *Arabis alpina*, *Bidens pilosa*, *Calamintha umbrosa*, *Clerodendron trichotomum*, *Corcopsis trichosperma* (84), *Crepis virens*, *Impatiens Balsamina*, *Microseris senella*, *Phtheirospermum Chinense*, *Saxifraga punctata*, *Senecio Cineraria* (cult.), *S. Muhlenbergii*.

Hosts recorded for the aggregate: "*S. Castagnei* Lév." *add:* *Arctium minus* (19), *Bupleurum linearifolium* (59), *Calendula fulgens* (40), *Centaurea Babylonica* (59), *Cnicus arvensis* (65), *Plantago major* (80), *Veronica Chamaedrys* (76), *V. orientalis* (40).

Hazslinszky described in 1878 (**28**) a *Sphaerotheca* from Hungary as a new species under the name *S. microcarpa*, with the

following diagnosis (I am indebted to Professor A. Mágócsy-Dietz for the translation of the Hungarian): "*S. microcarpa* nov. spec. Mycelium spinnwebartig, weiss. Perithecien zerstreut, sehr winzig, kugelig, endlich schwarz, mit einem kugligen Ascus. Die Wand des Ascus ist sehr dünn auf der sich papillös erhebenden Spitze. Unter dem Ascus, entgegengesetzt dem Scheitel, sitzt ein Discus mit kuchenartiger Gestalt, von welchem der Ascus sich schwer loslöst. In dem Ascus befinden sich 6–8 elliptische Sporen. Die Anhängsel sind weiss, unregelmässig und bestehen aus ungetheilten Fäden.—Wächst auf der unteren Fläche der Blätter von *Xanthium spinosum* im Comitate Ung (Ungarn). Es ist leicht möglich, dass der Pilz nicht selten ist und überall die Wirthspflanze begleitet." From the description given it is evident that the fungus is *S. humuli fuliginea*, which is found not uncommonly on *Xanthium spinosum*, *X. strumarum*, *X. Canadense*, *X. Italicum*, etc.

S. phtheirospermi P. Henn. & Shirai, Engler's Bot. Jahrb. **29**: 147. 1900, on *Phtheirospermum Chinense*, Mt. Takao, Prov. Musashi, Japan (Kusano, no. 130, Nov. 8, 1899), is typical *S. humuli fuliginea*, quite similar in all respects to European examples on *Taraxacum officinale*, and on a number of hosts belonging to the Scrophulariaceae (*Bartsia*, *Euphrasia*, *Melampyrum*, *Pedicularis*, etc.). The specimen, labelled as above, of "*S. phtheirospermi*" (now in the Kew Herbarium) kindly sent to me by Dr. Hennings, shows perithecia 60–90 μ in diam., with the cells of the outer wall large and distinct, and measuring 15–30 μ wide; the appendages are few and distinct; the ascus is broadly ovoid to subglobose, and measures 50–60 × 45–50 μ. *S. humuli* var. *fuliginea* occurs not uncommonly on a number of plants in Japan (see "Erysiphaceae of Japan" (**68**, p. 446)).

Serbinov (**76**) has transferred the *Erysiphe fuscata* of Berk. & Curt. (Grevillea, **4**: 159. 1876), to the genus *Sphaerotheca*, giving the plant the name *S. fuscata* (B. & C.) Serbin. Serbinov, however, has overlooked the fact that, as pointed out by Burrill (Ellis and Everhart's N. Amer. Pyren. 8), and at p. 51 of my monograph, "*E. fuscata*" is identical with *S. humuli fuliginea*.

The fungus recorded as *S. Castagnei* by Rabenhorst (**59**) on *Euphorbia* from Persia, proves to be *Erysiphe taurica* Lév.; that

recorded (*l. c.*) under the same on *Hibiscus esculentus* bears, according to specimens from Rabenhorst's herbarium, no perithecia, but, from the mycelial characters shown, probably also belongs to *E. taurica*.

The *S. Castagnei* recorded by Magnus (Bericht. des naturwiss.-med. Ver. Innsbruck, **24** : 6. 1898, on *Caltha palustris*, proves to be a small form of *Erysiphe polygoni* DC.

The fungus recorded as *S. humuli* Schroet., on *Plantago major*, by Feltgen (**18**), proves from specimens sent to be *E. cichoracearum* DC.; and that recorded (*l. c.*) under the same name as occurring on "*Mentha longifolia*" proves from specimens sent to be *S. humuli fuliginea* on *Veronica longifolia*.

The plants recorded as *S. Castagnei* Lév. *p.p.* Burr. (= *S. humuli fuliginea*) on *Shepherdia argentea* and *Collomia linearis* from Wyoming, by Griffiths (Bull. Torrey Club, **26**: 142, 143. 1899), prove from specimens sent by the writer to belong to *S. humuli* (DC.) Burr. They are small forms of the species—the perithecia in the example on *Collomia*, measuring 75–100 μ in diam., and in that on *Shepherdia* 90–110 μ—with quite the general appearance of the var. *fuliginea*, but with the cellular structure of the perithecium characteristic of the *S. humuli* type.

S. PANNOSA (Wallr.) Lév. (Monograph, p. 65)

Exsicc. add: * Linhart, Fung. hungar. 354.

Distrib. add Europe, Austria-Hungary; Australasia, Tasmania (62).

Hosts, add: Rosa Eglanteria (40), *R. fragrans* (40).

Spegazzini records (**79**), *Oidium leucoconium* Desm. as occurring "ad folia viva *Rosarum* cultarum vulgatum in tota Republica Argentina et in Montevideo, per ann., 1880–1897." If correctly determined, this refers to *S. pannosa*, as *Oidium leucoconium* is the conidial stage of this species; it may be noted, however, that in North America a peculiar form of *S. humuli* occurring on roses has commonly been mistaken for *S. pannosa* (see monograph, p. 68).

The fungus reported by Goethe (**21**) as *S. pannosa*, occurring on apple trees in Germany, proves to be *Podosphaera leucotricha*. In the case of Cavara's record, also mentioned by Magnus (46), of

S. pannosa on apple trees, the same mistake in identification has in all probability been made.

The fungus known as the "peach mildew" is apparently *S. pannosa*, although some writers, *e. g.*, Waite and Bailey refer it to *Podosphaera oxyacanthae* (see p. 85). This doubt as to the specific identity of the mildew on the peach is due probably to the fact that—as in the case of *Podosphaera leucotricha* on the apple—the conidial stage, which causes the injury, is usually the only stage in which the fungus occurs. I have, however, seen in a European example, the pannose mycelium of the perithecial stage of *S. pannosa* on the stem of a peach tree.

Smith (Journ. Mycol. **7**: 90, 91. 1892, and Selby (**75***) both refer to the "peach mildew" as "*S. pannosa*," and give the following accounts of the injury caused by it. Smith observes: "This mildew usually attacks the leaves and young stems. On the latter it forms a dense, felt-like, persistent hyphae-complex which is first white and afterwards a dirty gray, the epidermis being cracked open and destroyed or much injured and a thick brown layer of cork being formed under the mycelial patches. The mildew produces conidia in abundance, but perithecia have not been found, although the search has been continued into winter." Smith noticed that the disease recurred year after year upon the same individual peach trees, whilst the surrounding trees were entirely free, and remarks: "The fungus has been found on the unfolding shoots of a tree so early in the spring and to such an extent as to make it almost certain that it had wintered over in the form of perennial mycelium. From other trees fresh-looking mycelium has been taken in mid-winter, and I have no doubt as to its perennial nature." It was found also that "peach trees with gland-bearing leaves remained free from mildew, while mildewed trees bore leaves destitute of glands." Smith remarks: "It would seem, therefore, as though peach trees of the type bearing glandular leaves are more resistant to this mildew than other varieties, but whether this will hold good for all localities and all varieties remains to be seen."

Selby reports the "peach mildew" as attacking the fruit as well as injuring the leaves and twigs, and observes: "Upon the fruit, this mildew causes large, light-colored spots, with an enor-

mous multiplication of epidermal hairs or fuzz of the peach. Under the affected spots there is a hardening of the fruit and the consequent effect upon the quality is less marked though quite similar to that produced by the scab (*Cladosorium carpophilum* Thüm.). To cut and burn affected shoots is recommended as a preventative measure for mildew. Spraying is unlikely to yield favorable results."

Halsted (**23***), in mentioning the fungus on diseases observed on fruit trees during 1894 at the New Jersey Agricultural Experiment Station, remarks: "*S. pannosa* has interfered with the growth of the young twigs of peach trees, coating them over in much the same manner that *S. mors-uvae* does the stems of the gooseberry."

S. MORS-UVAE (Schwein.) Berk. & Curt. (Monograph, p. 70)

Distrib. add: Europe, in a garden, Ballymena, County Antrim, Ireland (? introduced). N. America, U. S., Utah (73), Indiana (84).

The appearance in 1900 of the "American gooseberry-mildew," *S. mors-uvae*, up to that time known only from the United States, in Ireland has already been noted (**51**) (**71** and **72**). In the present year (1901) the disease has reappeared in the same garden at Ballymena, County Antrim, and the gardener there has reported to me the following facts: "The disease this year was even more extensive than last; and the young wood seems more affected at this time of year (August) than it did last year. I have not heard of any neighboring gardens being affected as yet. Some varieties of gooseberries are far more subject to the disease than others. The "large green" gooseberry is not affected, while the "small green" is very much affected, although both berries are smooth. The "amber" is by far the worst of any. Some varieties of "red" seem proof against the fungus, while others are nearly as susceptible as the "amber"; the "smooth red" is the worst.

Magnus is of the opinion that the fungus has been introduced into Ireland from America, and suggests (**47**) that imported gooseberries bearing the fungus may have been the source of infection. This, however, cannot have been the case, as the authorities at the

Customs House (London), inform me that no importation of gooseberries into Britain from the United States occurs. I have learned, however, through Mr. F. W. Moore, of the Royal Botanic Gardens, Dublin, that two firms of florists in Ireland some years ago imported gooseberry plants from the United States. It is certainly possible that by this means the disease may have been introduced from America. But, on the other hand, we must remember that Ireland possesses some indigenous plants found elsewhere only in North America. Also, as I have already pointed out (monograph, p. 72), in the fungus known as *Sphaerotheca euphorbiae* (Cast.), which is not uncommon on the Continent on species of *Euphorbia*, appears to be morphologically indistinguishable from *S. mors-uvae*.

It may be noted here that De Wildeman (**16**) has lately enumerated *S. mors-uvae* among the Erysiphaceae of Belgium. The record runs, "sine loco (Em. Marchal)"; up to the present I have not been able to obtain any information about this Belgian record.

It may be well here to draw attention to the serious economic danger with which European fruit farmers will be confronted if this "American gooseberry mildew" is allowed to establish itself in Europe. The practical aspect of the subject is ably dealt with by Beach (**2****), in Bull. N. Y. Agric. Exper. Station, 114, where a full and well-illustrated account of the cultivation of gooseberries in the United States is given. It is here remarked: "The one great hindrance to the cultivation of European gooseberries in this country is their susceptibility to attacks of the mildew, *Sphaerotheca mors-uvae*. From the standpoint of the American fruit-grower gooseberries falls into two classes, those which suffer from the mildew and those which do not. The former class includes all European varieties and their American grown seedlings, or in other words, all varieties of the species *Ribes Grossularia* L. The latter class includes the cultivated varieties of the native American species *oxyacanthoides* L. and *Cynosbati* L., and some hybrids between them and the European species. * * * On account of their liability to serious attacks of mildew, European gooseberries should not be planted for commercial purposes, except by those who are prepared to contend with that disease." We may infer from these observations that if the fungus were to become wide-

spread in Europe, the whole gooseberry crop would be seriously affected. Beach (*l. c.*) observes: "spraying to prevent mildew should begin as soon as the buds begin to unfold, using one ounce of potassium sulphide for every two gallons of water. Repeat the applications at intervals of ten days till the fruit is nearly ready to market. Should frequent heavy rains occur spray more frequently. Be sure the spray reaches all the foliage, especially on the inner and under parts of the bush which are usually slighted. The use of Bordeaux mixture is objectionable because it is apt to stick to the fruit and injure its market value, even though the application be made several weeks before the crop is marketed."

A valuable account, describing the mode of attack, best methods of prevention, etc., has also been given by Halsted (**23**).

S. euphorbiae (Cast.) Salm.

Botrytis euphorbiae Cast. Supp. Cat. Pl. Mars. 81. 1851. (For further synonymy *cf.* Monograph, p. 71.)

Syn. add: *Oidium euphorbiae* Thüm. mss. in herb.

Exsicc. add: *Rehm. Ascomycet. 1049.

Hosts, add: *Euphorbia Cyparissias palustris.*

The specimen in the Kew Herbarium, ex herb de Thümen, named "*Oidium euphorbiae* Thüm. mss. on *Euphorbia dulcis*, Austria inf., Krems, 7.71" belongs to the present species.

S. LANESTRIS Harkn. (Monograph, p. 74)

Syn. S. Kusanoi P. Henn. & Shirai, Engler's Bot. Jahrb. **29**: 145. 1900.

Hosts, add: *Quercus glandulifera.*

Distrib. add: Japan; Prov. Kozuké, Mt. Myogi (Kusano, Nov. 4, 1899). Mt. Tsukuba (T. Nishida, Nov. 2, 1900)!

Hennings and Shirai (**31**) have lately described a *Sphaerotheca* from Japan as a new species under the name of *S. Kusanoi.* Dr. Hennings has kindly sent me a specimen of this fungus (now in the Kew Herbarium) labeled "on *Quercus glandulifera*, Prov. Kozuké, Mt. Myogi (Kusano, no. 123, Nov. 4, 1899)." This fungus is, in my opinion, *S. lanestris* in a slightly immature condition. The authors remark of *S. Kusanoi:* "Die Art ist mit *S. lanestris* Harkn. verwandt, aber duch das völlig farblose Mycel, durch die

pfriemlichen vom Mycel völlig getrennten Anhängsel, durch die am Scheitel nicht verdickten, 5–6 Sporen enthaltenden Asken, sowie durch die mit einem Tropfen versehenen, im Innern nicht gekörnelten Sporen gut verschieden." Of the character here given, the completely colorless mycelium would if constant be the most important, as separating the plant from *S. lanestris*, but this distinctive character certainly does not hold good. Although the specimen is undoubtedly for the most part immature, as is shown by the fact that the ascus of most of the perithecia is found, on being pressed out, to be still completely enveloped in the separating inner wall of the perithecium. But even in this stage some of the hyphae of the mycelium, intermixed with colorless ones, show a decided brown color under the microscope. Moreover, in one corner of a leaf in the specimen sent, a small patch of mycelium has turned completely brown, and presents all the appearances of that of *S. lanestris*. The appendages of the perithecium in "*S. Kusanoi*" are in most cases quite rudimentary or even absent; occasionally, however, they equal or slightly exceed, in length the diameter of the perithecium. The asci are 6–8-spored; the wall becomes thin towards the apex of the ascus (as is shown, *e. g.*, at Fig. 118 of monograph). The complete separation of the inner wall of the perithecium from the outer is a characteristic feature *S. lanestris* (see monograph, p. 75).

Since writing the above, I have received another example of this Japanese *Sphaerotheca* on *Quercus glandulifera*, from Professor Shotaro Hori, collected at Mt. Tsukuba (coll. T. Nishida, Nov. 2, 1900). In this specimen, although the fungus is immature, the mycelium has everywhere taken a decided tinge of brown.

S. lanestris has been known hitherto only from the United States, where it occurs on six species of *Quercus* in the Southern, Middle and Western States. Its occurrence in Japan is of great interest, adding as it does another species to the list of mildews common to North America and Japan (see "Erysiphaceae of Japan" (**68**, p. 442).

UNCINULA SALICIS (DC.) Wint. (Monograph, p. 81)

Exsicc. add.: *Linhart, Fung. hungar. 78; *Rehm, ascomycet. 549b; * Fl. exsicc. austro-hungar. 3177; * Krypt. exsicc. (Mus. Pal. Vind.) 121; Shear, New York Fungi 140 (in herb. Jaczewski).

Distrib. add: Europe; Bosnia (10).

Hosts, add: Populus suaveolens, Salix gracilistyla, S. multinervis, S. stipularis.

Sredinski (80) has recorded from Russia the occurrence of *U. salicis* on *Hedera Helix.* In all probability, however, the perithecia in this case were merely adhering by means of their appendages to the leaves, as it is most unlikely that the *Hedera* was really serving as a host plant. "*U. salicis* var. *epilobii* Vestergr." on *Epilobium angustifolium* and "*U. Columbiana* Selby on *Scutellaria lateriflora* afford apparently similar cases (*ante*, p. 10).

Brannon (8) has recorded the occurrence in rare cases, of eight spores in the ascus of *U. salicis.*

The haustoria of *U. salicis*, according to the observations of Grant Smith (77), differ in an important manner from those of other species of the Erysiphaceae, being produced not only in the epidermal cells of the host-leaf, but also in the subepidermal (palisade and mesophyll) cells (*ante*, p. 4).

U. MIYABEI Salm. (*U. salicis* var. *Miyabei* Salm. monograph, p. 88)

Hosts, add: Tilia Miqueliana.

From the study of further material, the present fungus, originally described as a variety of *U. salicis*, seems to be worthy of specific rank, the character of the appendages (especially that of the basal part becoming, when mature, thick-walled) separating it clearly from all forms of *U. salicis.* Further, I have not been able to find among numerous specimens of *U. salicis* from Japan. any forms approaching in any way *U. Miyabei*, such as might be expected to occur were the latter only a variety of *U. salicis.* Since its original discovery in Japan on *Alnus incana* and *A. maritima*, *U. Miyabei* has been found at Hokkaido, Prov. Ishikari, Shintotsugawa (coll. T. Hawakami) on *Tilia Miqueliana* see Erysiphaceae of Japan (68), p. 440.

U. ACERIS (DC.) Sacc. (Monograph. p. 90)

Exsicc. add: *Krypt. Exsicc. (Mus. Pal. Vind.) 123; *D. Sacc. Myc. Ital. 60; *Linh. Fung. hungar. 77, 256.

Distrib. add: Bosnia.

Hosts, add: Acer opulifolium, A. palmatum, A. spicatum Ukuruduense.

In the examination of some *U. aceris* in the conidial stage on *Acer campestre* from Reigate, England, there was observed on all the leaves examined *Oidium*-like conidia much smaller than the normal *Oidium*-conidia with which they were associated. I was not able to ascertain if these smaller conidia which measured about 15 × 7 μ, were organically connected with the mycelium of the *Uncinula*, *i. e.*, whether they were really microconidia, or whether they were merely accidentally present. The presence of some intermixed hyphae of foreign mycelium and loose *Macrosporium* and other spores favor the latter view. The occurrence of these smaller *Oidium*-like conidia among the mycelium of *U. aceris* is of interest in connection with Fuckel's original description of the conidia of *U. Tulasnei* (see monograph, p. 94).

Rabenhorst (**59**) has recorded *U. aceris* on *Acer monspessulanum* from Boriter in Kurdistan. Specimens so labelled were kindly sent to me by Dr. Hennings from Rabenhorst's herbarium, but these bore only a barren mycelium.

Neger (**54**, p. 338) states that the conidia of *U. aceris* vary in shape according to external conditions,—to quote his words: "Die Conidien zeigen je nach den Wachsthumsbedingungen (feuchter oder trockener Umgebung) verschiedene Gestalt; in trockener Luft entstandene Sporen sind lang und schlank, während sie in feuchter Umgebung mehr abgerundete und gedrungene Formen zeigen."

U. PRUNASTRI (DC.) Sacc. (Monograph, p. 95)

Distrib. add: Bulgaria (10), Poland (6).

In Spegazzini's herbarium a specimen occurs labelled "*U. Wallrothii f. loniceræ Xylostei*, Belluno, Italy, 10. 8. 78; rarissime." I had already (monograph, p. 97) expressed the opinion that the presence of *U. Prunastri* on the host here given was to be considered only accidental, and an examination of these specimens of Spegazzini shows this view to be correct. We find here that the perithecia—or at least many of them—are fixed upside down by means of the adherence of the mucilaginous apices of the appendages to the leaf of the *Lonicera*. This reversal and reattachment of the perithecium is just what occurs in *U. aceris* (see monograph, p. 92), and has also been observed in several other species of the present genus (*ante*, p. 9).

U. CLANDESTINA (Biv. Bern.) Schroeb. (Monograph, p. 97)

Syn. add: *U. clandestina* Bivon. form. n. *Japonica* P. Henn. Engler's Bot. Jahrb. **29**: 149. 1900.

Hosts, add: *Ulmus parvifolia.*

The "forma *Japonica*" of Hennings (*l. c.*) from Tokyo: Botan. Garten auf lebenden Blättern von *Ulmus campestris* Sm. var. *vulgaris* Pl. (Kusano, no. 155, Oct. 11, 1899) is described as follows: "Die Form ist durch Grössenverhältnisse von der typischen Art etwas unterschieden. Die Perithecien sind 75–85 μ gross mit meist 20 an der Spitze hakenförmig gekrümmten 60–80 μ langen Anhängseln. Die 2–3 Asken jedes Peritheciums sind eiförmig 40–60 × 40–55 μ, mit 2–3 elliptischen 19–25 × 14–18 μ grossen, gelblichen, granulierten Sporen." There are no characters given here of sufficient importance to justify the separation in any way of the Japanese plant from the *U. clandestina* of Europe and Algeria. I have seen several specimens of *U. clandestina* from Japan, and have found them identical with European examples of the species. It may be noted that in Hennings' description, the measurement of the spores is given as "19–25 × 14–18 μ"; in a specimen (now in the Kew Herbarium) sent to me by Dr. Hennings; however, the spores measure up to 30 μ long.

U. NECATOR (Schwein.) Burr. (Monograph, p. 99)

Exsicc. add: Shear, New York Fungi, 141 (in herb. Jaczewski).

Distrib. add: Europe, Germany, N. America, U. S., Georgia (74). S. America, Chili (37).

Hosts, add: *Vitis cordifolia* (84).

The interesting discovery at Geisenheim in Germany of the occurrence of perithecia of *U. necator*—hitherto known in Europe only from France—has been made by Dr. G. Lüstner, who gives (41) the following account: "Die von mir aufgefundenen Perithecien wurden an einer an einem Geiztrieb gebildeten Traube, an welcher gleichzeitig auch conidienbildendes Mycel vorhanden war, am 15 November angetroffen; sie sassen an den Beerenstielen in Gruppen beisammen." Dr. Lüstner kindly sent me a microscopic mount of some of the perithecia. These latter, which undoubtedly belong to *U. necator*, are immature, some of the appendages being still uncolored and not yet showing the uncinate

apex. The fungus at this stage somewhat resembles *Erysiphe polygoni*—a fact which very probably accounts for the record by Berkeley (Gard. Chron. **21**: 22. 1884, of the occurrence of "*Erysiphe communis*" on vine leaves, from Washington, U. S. A., growing with *U. necator*.

Professor H. O. Juel has informed me that he found in Sept., 1900, at Bonn, Germany, "one leaf of *Vitis vinifera* that was covered with *Oidium*, and had also some well-developed perithecia of *Uncinula spiralis*."

It still seems necessary to assume, however, that *U. necator*, although occasionally producing perithecia in Europe, as a rule survives the winter by means of persistent mycelium or hibernating conidia. (See Wortmann, **88**.)

Pierce (**58***) in his monographic study of the "California Vine Disease," gives a full account of the manner in which *U. necator* attacks the vines of California.

U. MACROSPORA Peck. (Monograph, p. 107)

Exsicc. add: Shear, New York Fungi, 143 (in herb. Jaczewski).

U. CLINTONII Peck. (Monograph, p. 109)

Syn. add: U. Kusanoi H. & P. Syd. Mém. Herb. Boiss. **4**: 4. 1900. *U. Zelkowae* P. Henn. Engler's Bot. Jahrb. **29**: 149. 1900.

Exsicc. add: *Rehm, Ascomycet. 1198; Shear, New York Fungi, 142 (in herb. Jaczewski).

Distrib. add: Florida.

Hosts. add: Celtis Sinensis.

As I have pointed out in the "Erysiphaceae of Japan" (**68**, p. 438) *U. Clintonii* is variable as regards the shape of its appendages. These may show a much enlarged clavate apex, often measuring 30 μ across, or the apex is only slightly enlarged, measuring 20 μ across. "*U. Kusanoi* H. & P. Syd." on *Celtis Sinensis* from Japan, has appendages of the latter description, and exactly matches certain examples of *U. Clintonii* on *Tilia Americana* from the United States.

The record of *U. Clintonii* from Florida is based on a specimen sent to Kew from the Florida Agricultural College, Lake City,

Fla. (coll. H. H. Hume). It is an interesting form of the species, the perithecia possess few (7–12) rather short appendages, very unequal in length on the same perithecium, and scarcely swollen at the apex.

"*U. Zelkowae* P. Henn." is described (31) as follows: "amphigena; mycelio arachnoideo, tenui, evanescente, albido; perithecciis gregariis, subglobosis, atris, 100–120 μ, appendicibus radiatis, simplicibus ca. 20, hyalinis, apice convolutis usque ad 10 μ incrassatis, 100–200 μ longis, 5–7 μ crassis; ascis (3) ellipsoideis vel subovoideis, 3–4-sporis, 35–50 × 30–40 μ, basi vix stipitatis; sporis ellipsoideis utrinque obtuse rotundatis, 1-guttulatis, hyalinis, 18–22 × 12–15 μ. Tokyo; auf lebenden Blättern von *Zelkowa acuminata* Pl. (Kusano, no. 153, Oct. 1, 1899)." The diagnosis here given shows that the fungus is the same as that sent to me from Kobe, Japan, on *Zelkova acuminata* (*Z. Keaki*), by Professor Kingo Miyabe. This I have described in my monograph, p. 110, and have given there my reasons for considering it only a small form of *U. Clintonii*.

U. POLYCHAETA (Berk. & Curt.) ex Ellis. (Monograph, p. 113)

Syn. add: *U. Shiraiana* P. Henn. Engler's Bot. Jahrb. **29**: 148. 1901.

Distrib. add: S. America, Uruguay, Argentine Republic, Tucuman and Salta (79).

Hosts, add: *Celtis Boliviensis* (79), *C. Selloviana* (61), *C. Sinensis*.

In some examples of this species sent by Spegazzini from Uruguay on *Celtis tala* many of the perithecia attained a diameter of 390 μ, and contained from 150–175 asci each.

"*U. Shiraiana* P. Henn." is a form with 2–4-, or very rarely 5-spored asci. It is not, I consider, distinct from *U. polychaeta* (see "Erysiphaceae of Japan," **68**, p. 439). *Phyllactinia corylea*, which usually possesses bisporous asci, shows much the same variation as the present species (see under that species).

U. VERNICIFERAE P. Henn.

U. verniciferae P. Henn., Engler's Bot. Jahrb. **29**: 149. 1900. Salm. Bull. Torrey Club, **27**: 440. 1900.

Distrib.—Japan: Tokyo, Botan. Garten. (Kusano no. 151, Oct. 27, 1899). Prov. Szumo (Tanaka, Nov. 29, 1900).

Hosts.—*Rhus succedanea* (fruit), *R. vernicifera* (leaves).

Hennings (*l. c.*) gives the following diagnosis: "amphigena; maculis fuscis effusis, mycelio arachnoides tenui, albido; perithecciis gregariis subglobosis, atris 100–110 μ; appendiculis 12–16, simplicibus, subulatis interdum apice cirrhatis 100–150 × 6–10 μ, hyalinis; ascis (2–3) ellipsoideis, vel subovoideis vix stipitatis, 8 sporis 40–50 × 35–45 μ; sporis ellipsoideis, utrinque rotundatis, 1 guttulatis, hyalinis, laevibus 17–20 × 9–11 μ. Die Art is mit *U. flexuosa* Peck und *U. aceris* DC. verwandt, durch die viel weniger askenreichen Perithecien u. s. w. verschieden."

Dr. Hennings sent me a specimen of his species (from Tokio), and on this I have remarked ("Erysiphaceae of Japan," **68**, p. 440). "The specimen sent is too immature to enable me to give a full description of the plant. It appears, however, a distinct species, showing affinity with *U. Sengokui* Salm., but differing in the thicker walled appendages, slightly narrowed upwards to the closely coiled frequently helicoid apex."

I have since received from Professor Shotaro Hori an *Uncinula* which proved on examination to be the above species on the fruit of *Rhus succedanea*. The mycelium of the fungus covers the numerous depressions which occur in the fruit of the *Rhus*, and in the specimen sent bears only a few immature perithecia. The appendages are sometimes as few as seven in number; they are not swollen upwards, and terminate in a closely coiled often helicoid apex; towards the base they become refractive and thick-walled.

U. SEPTATA Salm.

U. septata Salm. Journ. Bot. **38**: 427. 1900.

Host.—*Quercus glandulifera*.

Distrib.—Japan: Mt. Myogi, Prov. Kozuké, (Kusano, Nov. 4, 1899, no. 123 (in part); Mt. Tsukuba (T. Nishida, Nov. 2, 1900).

"Hypophyllous: mycelium evanescent; perithecia more or less scattered, large, rounded-lenticular, 160–210 μ in diameter, cells of outer wall of perithecium distinct, small, 5–10 μ wide; appendages crowded, very numerous, 100–170 or more in number,

unequal in length (50–100 μ long) on the same perithecium, simple, smooth, 1–8- (usually about 5-) septate, amber-colored in the lower half, thin-walled throughout, about 5 μ wide, apex often helicoid; asci 6–12 (immature). In habit, and in the large size of the perithecia, *U. septata* resembles *U. circinata* Cooke & Peck, from which it is at once distinguished by the septate appendages; from *U. necator* (Schwein.) Burr. and *U. australiana* McAlp.—the only species of the genus at present known which possess colored (septate) appendages—the large perithecia with the crowded appendages at once distinguish the present species. The absence of spores in the ascus shows that the specimens examined are immature; but I have no hesitation in describing the plant in this condition, as the presence of densely crowded septate appendages shows it to be quite distinct from all other species at present known. The appendages when well developed cover more or less completely the upper half of the perithecium—just as is the case in *U. circinata*. Seen in the mass, the appendages are of a pale amber tint; very probably they acquire towards the base, on maturity, a deeper shade of brown, like those of *U. necator*." Salm. (*l. c.*)

U. septata was first found associated with "*Sphaerotheca Kusanoi* P. Henn., of Shirai," on a leaf of *Quercus glandulifera*, in a specimen sent to me by Dr. Hennings. I have since, through the kindness of Dr. Hennings, been able to look over all the original material of "*S. Kusanoi*," but have not been able to find any perithecia sufficiently ripe to contain spores; I have observed, however, that the appendages are frequently 10-septate. Professor Shotaro Hori has sent me a specimen of *S. lanestris* ("*S. Kusanoi*") or *Quercus glandulifera* from Mt. Tsukuba (coll. T. Nishida, Nov. 2, 1900), and on the leaf a few immature perithecia of *U. septata* occur. It is interesting to find that in this, its second known locality, the present species again occurs associated with the *Sphaerotheca*.

MICROSPHAERA BERBERIDIS (DC.) Lév. (Monograph, p. 123)

Exsicc. add: * Linhart, Fung. hungar. 258.

Distrib. add: Italy.

M. EUONYMI (DC.) Sacc. (Monograph, p. 125)

Exsicc. add: Krieger, Fung. saxon. 1225 (in herb. Jaczewski).

Hosts, add: Caragana frutescens.

In Professor Jaczewski's herbarium there occurs a most interesting mildew on *Caragana frutescens* Medic. from Russia, which with scarcely any doubt must be referred to *M. euonymi*. The fungus forms when mature clinging floccose masses chiefly on the under surface of the leaf; the perithecia measure 100–130 μ in diameter; the appendages are 12–24 in number, 3–5 times the diameter of the perithecium, flaccid and penicillate when mature, with the apex dichotomously branched; asci 4–9, about 60 × 30 μ, 3–5-spored, spores 22–23 × 11–12 μ. The branching of the apex is represented at *Pl. 9, f. 3–5*, and agrees with that found in some forms of *M. euonymi* on *Euonymus Europaeus;* although the apex is perhaps scarcely so much branched as is usual for the species. The type of branching is, however, quite different from that found in *M. Bäumleri* P. Magn., the only other species to which this fungus on *Caragana frutescens* approaches. I have seen only the single Russian specimen mentioned above; and in this, although the perithecia are sufficiently ripe to contain asci with spores, the final branching of the apex of the appendages has not apparently in many cases yet taken place. There is, however, an exact agreement between the branching shown by some of the appendages and that which occurs in some examples of *M. euonymi*. The occurrence of *M. euonymi*, so long known only on *Euonymus*, on another genus of host plants is a notable fact. *M. Caraganae* P. Magn. Bericht. deutsch. bot. Gesellsch. **17**: 150. *pl. 9. f. 1–4.* 1899, on *Caragana arborescens* is in my opinion not a *Microsphaera* at all, but a form of *Erysiphe polygoni* DC. (see monograph, p. 187).

Serbinov (**76**) has lately described from Russia (Gouv. St. Petersburg) a form of *M. euonymi* as a new variety under the name var. *borealis*. I have not seen a specimen of the plant. The following diagnosis is given: "Varietas hypophylla, a *M. euonymi* (DC.) Sacc. mycelio differens persistente, compacto, floccoso, peritheciis gregariis. — Die von mir in einem alten Garten Oranienbaums auf *Euonymus Europaeus* gefundene *M. euonymi* Sacc. hat ein interessantes Mycel. Dasselbe entwickelb

sich so kräftig und stark dass ein von ihm befallenes Blatt wie mit Spinngewebe überzogen erscheint. Nach den Angaben von Saccardo ist das Mycel dieses Pilzes *arachnoideus et fugax*, während es bei von mir gefundenen Exemplaren *floccosus* and *persistens* ist. In Folge eines solchen Unterschiedes des von mir gefundenen Pilzes mit der typischen *M. euonymi* Sacc., fasse ich erstere als eine nördliche Varietät auf, und nenne sie *M. euonymi* (DC.) Sacc. var. *borealis* (mihi)."

M. ASTRAGALI (DC.) Trev. (Monograph, p. 127)

Neger (**54**, p. 353) states that in all the mature examples of *M. astragali* which he examined, he found the appendages of neighboring perithecia wound round and so bound together by the hyphae of some secondary fungus, usually *Monilia candida*.

Exsicc. add: Krieg. Fung. saxon. 1222 (in herb. Jaczewski).

Syn. add: Trichocladia astragali (DC.) Neger, Flora, **88**: 351. 1901.

M. ALNI (Wallr.) Salm. (Monograph, p. 129)

Syn. add: M. syringae (Schwein) P. Magn. Bericht. deutsch. bot. Gesellsch. **16**: 67. 1898.

M. Myoschili Neger, Bericht. deutsch. bot. Gesellsch. **17**: Generalversamm.-heft. (241), 1899.

M. Japonica P. Henn. Engler's Bot. Jahrb. **28**: 271. 1900.

Exsicc. add: *Rehm, Ascomycet. 1117, 1299; *Krypt. Exsicc. (Mus. Pal. Vind.), 128; Shear, New York Fungi 144 (*sub M. vaccinii* (Schw.) Cooke & Pk.) in herb. Jaczewski; *Jacz. Kom. Franz. Fung. Ross. exsicc. 337*b* (*sub M. berberidis* (DC.) Lév.).

Hosts, add Berberis vulgaris, Betula pumila (84), *Carpinus Americana* (84), *Chionanthus Virginica, Corylus rostrata Sieboldiana, Ilex verticillata* (84), *Lathyrus palustris, Lonicera hirsuta, L. Sullivantii, Myoschilos oblongum, Quercus discolor, Q. serrata, Styrax Japonicum.*

Distrib. add Europe: Bosnia (10). North America: U. S. A., Florida. South America: Argentine.

Dr. Neger has kindly sent me a specimen (now in the Kew Herbarium) of "*M. Myoschili*" on *Myoschilos oblongum*, from

"prope lacum argentinum dictum Quillen in Andibus valdivianis, vulgatissima." The plant shows these characters: perithecia 90–130 μ in diameter, cells of outer wall of perithecium 10–15 μ wide; appendages 5–20, 1–1½ times, or rarely twice, the diameter of the perithecium, becoming thick-walled toward the base when mature, apex 4–6 times regularly dichotomously branched, tips of ultimate branches recurved; asci 4–12, 45–55 × 30–35 μ, spores 3–5, rarely 6. The fungus is, I feel convinced, merely one of the forms of the polymorphous species *M. alni*, with a much-branched apex to the appendages. Quite similar forms are common in the United States on several host-plants, *e. g.*, on species of *Quercus* on *Menispermum Canadense*, *Cornus alternifolia*, etc. Occasionally, moreover, in "*M. Myoschili*" the apex of the appendage is only 4 times dichotomously branched, and the fungus is then seen to be identical with the more common form of *M. alni*. In some instances—evidently to be regarded as "sports"—an appendage occurs which forks from near its base into two wide branches, each of which is dichotomously divided at the apex as in a normal appendage. Dr. Neger's figure (*l. c.*, *Pl. 28*, *f. 7*) represents the apex of an appendage in an immature condition—the tips of the ultimate branches (here shown as straight) become revolute at maturity (see *Pl. 9*. *f. 10*).

In Rehm's Ascomycet., no. 1117, there is a very interesting example of *M. alni*, collected by Professor P. Magnus on *Rhamnus catharticus* at Brandenburg, August, 1893. The apex of the appendage in many of the perithecia is more branched (see *Pl. 9*. *f. 11*) than is usual for the species in Europe, and exactly corresponds in this respect to certain American forms of *M. alni* on *Quercus*, *Cornus*, etc., which have by some authors been considered as distinct species under the names of *M. pulchra*, *M. quercina*, etc. The branching of the apex of the appendages in this Brandenburg specimen agrees so closely with that found in "*M. Myoschili*" (see above) as to show clearly that the latter must be regarded as merely a form of *M. alni* (*cf. Pl. 9*. *f. 10*, *11*).

A rather remarkable form of *M. alni* has been sent by Professor Kingo Miyabe on *Corylus rostrata* var. *Sieboldiana* from Hakkoda Mountains, Prov. Mutsu, Japan (N. Hiratsuka, August 26, 1897)." Unfortunately the fungus is immature. The specimens

are remarkable for possessing appendages which are 2–4-septate and colored below for half their length or more and are often geniculate or irregularly bent. Only one mature apex of the appendages was found and this was identical with that of *M. alni*, being four times dichotomously branched, with the tips of the ultimate branches regularly recurved. The form certainly requires further study. As regards the presence of colored appendages, a similar Japanese form on *Corylus rostrata Mandschurica* has already been noted (monograph, p. 142).

The fungus set out as "*M. berberidis* (DC.) Lév., in foliis vivis *Berberidis vulgaris* L., Petrovsko-Rasumoskoje prope Mosquam, 1899 XI. Legit Serebriaunikov," in Jacz. Kom. Franz. Fung. Ross. exsicc. no. 337*b* is certainly not that species, but *M. alni*. The specimens are immature, and the appendages of most of the perithecia have an undeveloped apex, here and there, however, one may be found in which the apical branching characteristic of *M. alni* has occurred (see *Pl. 9. f. 16, 17*). The occurrence of the present species on *Berberis vulgaris* and the presence of mycelium and young perithecia show that it is undoubtedly growing on this plant is most interesting, as *Berberis* is the usual host-plant of *M. berberidis*.

Freeman's record (**20**) of the occurrence of *M. alni* on *Tilia Americana*, from "Hennepin, Minnesota, U. S. A. (Freeman, no. 58, 1898)" proves to be due to an error, the host plant having been wrongly identified. According to specimens sent to me, the fungus is growing on *Corylus Americana*.

"*M. Japonica* P. Henn." on *Cornus macrophylla*, from Japan, cannot be distinguished from *M. alni* (see "Erysiphaceae of Japan," **68**, p. 439).

M. ALNI LONICERAE (DC.) Salm. (Monograph, p. 142)

Exsicc. add: Krieger Fung. saxon. 1224 (in herb. Jaczewski).

Hosts, add: Syringa vulgaris.

I have had the opportunity, through the kindness of Professor P. Magnus, of examining the specimen of "*M. Ehrenbergii*" (= *M. alni lonicerae*) found by Allescher (see Bericht. botan. Verein. Landshut, 146–152. 1887) on *Syringa vulgaris*. The fungus certainly appears to belong to the present variety. The

Syringa affected stood in close proximity to a bush of *Lonicera Tatarica* attached by the same fungus, so that it would appear that we have here a case of a species of mildew passing directly from one host-plant to another.

M. ALNI DIVARICATA (Wallr.) Salm. (Monograph, p. 146)

Exsicc. add: Krieger, Fung. saxon. 1223 (in herb. Jaczewski).

M. ALNI EXTENSA (Cooke & Peck) Salm. (Monograph, p. 152)

Exsicc. add: Shear, New York Fungi, 146 (*sub M. quercina* (Schw.) Burr. (in herb. Jaczewski).

Hosts, add: Quercus cinerea.

Distrib. add: North America; United States, Florida.

The examples from Lake City, Florida (coll. H. H. Hume), are interesting, as occasionally showing a pale brown color towards the base of the appendages.

M. ALNI LUDENS Salm. (Monograph, p. 154)

Distrib. add: North America; U. S., Helena, Montana (F. D. Kelsey).

Kelsey has recorded (Journ. Mycol. **5**: 83. 1889), the above Montana plant on *Vicia Americana lincaris* as "*Erysiphe communis* (Wallr.) Fr." Specimens sent by the author, however, show that the fungus belongs to the present variety of *M. alni.*

M. GROSSULARIAE (Wallr.) Lév. (Monograph, p. 157)

Syn. add: M. sambucicola P. Henn., Engler's Bot. Jahrb. **29**: 148. 1900.

Exsicc. add: Shear, New York Fungi, 145 (in herb. Jaczewski).

Distrib. add: New Zealand (36) (56).

In a "Leaflet for Gardeners," issued by the New Zealand Board of Agriculture (**56**) the present species, which sometimes seriously attacks cultivated gooseberry bushes, is recorded from New Zealand. Bordeaux mixture, or sulphide of potassium (1½ lbs. to 50 gallons of water) is here recommended as a fungicide.

"*M. sambucicola* P. Henn." on *Sambucus racemosa* from Tokyo, Japan, is quite similar to American examples of *M. grossulariae* on *Sambucus racemosa* and *S. Canadensis* (see "Erysiphaceae of Japan" (**68**, p. 439).

M. MOUGEOTII Lév. (Monograph, p. 159)

Distrib. add: Poland (6).

M. DIFFUSA Cooke & Peck. (Monograph, p. 161)

Distrib. add: N. America, U. S., Indiana (84).

M. EUPHORBIAE (Peck) Berk. & Curt. (Monograph, p. 164)

Distrib. add: N. America, U. S., Indiana (84).

M. BÄUMLERI P. Magn. (Monograph, p. 170)

Ref., add: Salm. Journ. Quekett Micr. Club, II. **7**: 371. *pl. 20. f 1–3.* 1900.

Exsicc. add: * Krypt. Exsicc. (Mus. Pal. Vind.) 131 (b, only) *sub Erysiphe pisi.*

Distrib. add: Switzerland, Sweden.

Hosts, add: ? *Lathyrus niger.*

The fungus recorded by Tolf (Bot. Notiser, 1891: 219) as *Erysiphe Martii* Lév. on *Vicia cassubica* from Småland, Sweden, proves, from specimens communicated to me by the author, to be the present species, which has not previously been known from Sweden.

Jaczewski, in his "Monographie des Erysipheés de la Suisse," 729 (Bull. Herb. Boissier, **4**: 1896), has recorded "*Erysiphe Martii* Lév., on *Vicia* sp., Aug. 29, 1891, herb. Jaczewski no. 76." From a specimen, so labelled, I find the fungus to be *M. Bäumleri*,—a species new to Switzerland.

The fungus recorded by Feltgen (**18**) as "*Erysiphe Martii* Lév. on *Lathyrus niger* proves, from specimens sent (now in the Kew Herbarium) to be a *Microsphaera* in an immature condition. Several appendages were found with the apex once dichotomously branched, and in one case an apex was observed which had forked twice. For the present this fungus on *Lathyrus niger* must be referred doubtfully to *M. Bäumleri.*

(To be concluded)

Texas Fungi.—I. Some new Species of Puccinia

By W. H. Long, Jr.

The following species were collected by the writer in 1900–1901, mainly in the vicinity of Austin, Texas. They were submitted to Mr. E. W. D. Holway (to whom I am under many and lasting obligations for the many favors shown me), and also to Dr. P. Sydow.

The descriptions and drawings were made by the writer. The drawings, by the aid of an Abbe camera lucida, represent such forms as are usually seen under the microscope. They are made mainly from material boiled and mounted in lactic acid, as specimens thus treated are more nearly restored to their normal shape and size than when mounted in water; besides the acid brings out the germ pores and minor details. All drawings are made to the same scale; a Bausch and Lomb one-inch ocular, and one-sixth inch objective were used, with the paper on a level with the base of the microscope, and are reduced one-half in reproduction.

Where the writer has more than one collection of a species, he has thought it best to mark, as type, that special collection from which the drawings and descriptions were made; therefore under each species is given the date and number of the type material.

Puccinia cooperiae sp. nov.

I. Aecidia clustered into groups 3–6 mm. long, by 1–3 mm. broad. These clusters are scattered and intermixed with the uredo and teleutosori. Aecidia orange, oval-elliptical or orbicular, .3–.4

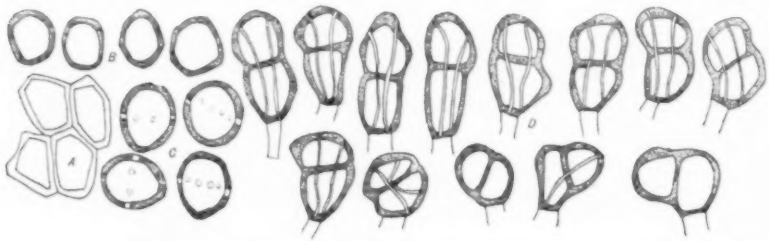

Fig. 1. *Puccinia cooperiae* on *Cooperia Drummondii*. *A*, four pseudoperidial cells. *B*, aecidiospores. *C*, uredospores. *D*, various forms of teleutospores.

mm. in diameter. Pseudoperidium prominent, somewhat reflexed and lacerate, white when desiccated. Cells of the pseudoperidium oval to irregularly polygonal. Aecidospores orange, oval, globose or irregularly polygonal, smooth or faintly granulose, 20–25 × 20–33 μ.

II. and III. Sori scattered over the leaves, intermixed.

Uredosori elliptical, chrome yellow, surrounded by the ruptured epidermis, .5 × 1–3 mm.

Uredospores yellow, minutely echinulate, obovate to globose, content yellow, appearing as oil globules when boiled in lactic acid; germ pores apparently six and equatorially placed, 20–26 × 26–33 μ.

Teleutosori blue-black, long covered by the epidermis, but finally dehiscing through a median longitudinal fissure, surrounded by the ruptured epidermis, elliptical, .5–1 × 1–3 mm.

Teleutospores chestnut brown, smooth, very irregular in shape and insertion of the pedicel, especially the earlier spores; usually oblong to oblong-oval, 20–26 × 33–50 μ; apex rounded, blunt or sometimes truncate; cells unequal, lower usually longer and more triangular than upper; epispore prominently marked by several (usually four) longitudinal lines; septum often oblique to insertion of pedicel; pedicel fragile, about 10 μ long, tinted.

On *Cooperia Drummondii*, Austin, Texas, Jan. 23, 1901, no. 1106; Jan. 24, 1901, no. 1107; Feb. 12, 1901, no. 1108; Feb. 28, 1901, no. 1111; March 2, 1901, no. 873; March 16, 1901, no. 874; April 6, 1901, no. 1113; April 27, 1901, no. 881. On *Cooperia pedunculata*, Austin, Texas, March 17, 1901, no. 1112 (II.).

This plant was first found in its aecidial stage, the latter part of January, 1901; from February to May all the stages were common, often on the same leaf. The later and fully mature teleutospores have the septa more normally placed and the longitudinal bands more prominent than those of the earlier teleutospores. Type of aecidial stage, March 2, 1901, no. 873 for II. and III., April 27, 1901, no. 881.

Puccinia cohaesa sp. nov.

II. Sori scattered on under surface of leaves, pale yellow, flat, powdery, orbicular to oval, .6–.75 mm., intermixed with the teleutosori.

Uredospores semihyaline, epispore pale yellow, echinulate, apex thickened for about 5 μ; germ pores four, equatorial; obo-

vate to oval-oblong, 15–18 × 28–40 μ. Paraphyses sparingly intermixed, hyaline, smooth, clavate to subcapitate, walls thick, pale yellow, 13–20 × 25–70 μ.

III. Sori usually scattered irregularly over the under surface of the leaves, but sometimes on both sides of the leaves and on the leaf stems, flat, purplish black, tardily naked, surrounded by the ruptured epidermis, powdery, very irregular in shape and size, from punctiform to orbicular and often 1–2 mm. in diameter; often concentric around a central sorus.

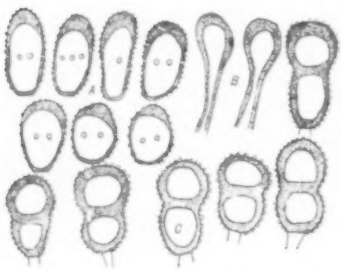

FIG. 2. *Puccinia cohaesa* on *Anemone Caroliniana*. *A*, various forms of uredo-spores. *B*, two paraphyses. *C*, teleutospores.

Teleutospores tuberculate, very uniform in size and shape, 20–23 × 34–50 μ; each cell usually regular in outline and subequal, firm, dark brown, spheroid, lower rarely attenuate, not easily breaking apart, constriction medium; tubercles large, short, blunt, not dense; few enough to be counted. Pedicel hyaline, short, sometimes length of spore.

On *Anemone Caroliniana*, Austin, Texas, March to May, 1900, no. 49; March 6 to April 25, 1901. Type for II. sori, March 14, 1901, no. 1126. Type III., April 25, 1901, no. 1127.

Through the kindness of Mr. M. A. Carleton, of the U. S. Department of Agriculture, the writer was enabled to compare this species with the U. S. Department specimens of *Puccinia fusca* from various parts of the world. This examination convinced him that *Puccinia cohaesa* was not *Puccinia fusca*; differing as follows: gross characters entirely different; microscopic characters also different, except as to size of the teleutospores; further, *Puccinia fusca* has no uredospores nor paraphyses, both of which are present with *Puccinia cohaesa*.

The water found constantly preceding and associated with *Puccinia cohaesa*, on the same plants, an aecidial form closely resembling *Aecidium punctatum*. As no positive proof of any connection between the two was at hand, the writer has not included an aecidial stage in this description, preferring to wait till cultures are made to determine this point. This rust like *P. cooperiae* continued until the leaves of the host were killed by hot water.

Puccinia Texana Holway and Long, sp. nov.

Sori hypophyllous on spots; spots ferruginous when fresh, dark brown when desiccated; sori orbicular to oval, firm, .4–.5 mm. in diameter, ferruginous, often confluent.

II. Uredospores globose to obovate, 20–26 × 23–30 μ, light brown, immature spores obovate to ovate-pyriform, walls thick, minutely echinulate, light brown, with four germ pores lying in two zones on either side of the equator.

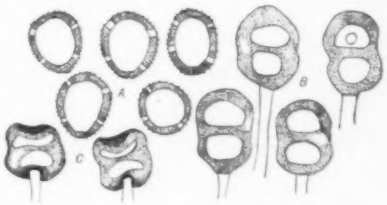

FIG. 3. *Puccinia Texana* on *Berberis trifoliolata*. *A*, uredospores. *B*, normal teleutospores. *C*, germinated teleutospores with apex and base depressed, the usual form seen in a water mount.

III. Teleutospores intermixed with the uredospores, often on the periphery of the sorus; teleutospores oval to slightly obovate; 20–28 × 26–40 μ; slightly constricted at the septum; apex somewhat or not at all thickened, cells subequal, epispore smooth, pedicel up to 50 μ long, hyaline; germinated and desiccated teleutospores collapsing inward at base and apex. (See Fig. 3, *c*.)

On *Berberis trifoliolata*, Austin, Texas, March 17, 1900, no. 44; Jan. to Dec., 1901. Type no. 44*a*, March 17, 1901.

This species is common in the vicinity of Austin, throughout the entire year on the *Berberis* bushes, but usually only a few of the lower leaves are attacked by it. The teleutospores germinate while on the bushes. After germination the base and apex are much depressed (see Fig. 3, *c*), and this is the form usually seen under the microscope when the mount is in water; but if the teleutospores are first boiled in lactic acid, they swell out to their normal shape and size (see Fig. 3, *b*). Both uredo and teleutospores are present during the entire year, but the uredospores seem to predominate during the winter and spring months. The spots on the leaves usually appear only when the sori are old and fully matured, young sori being without the spots.

Puccinia similis sp. nov.

I. Aecidia irregularly scattered over the under side of the leaves, oval, oblong or irregular in shape, .5–1 mm.; pseudoperidium white, much exserted, with four or more lacerate segments which collapse over the aecidia when desiccated. Aecidiospores

pale yellow, white when desiccated, verrucose, oval to globose, 20–27 × 27–30 μ.

II. Uredosori irregularly scattered over the under side of the leaves, often aggregated into groups, small, from punctiform to .5 mm. in diameter, powdery, ferruginous, often intermixed with the aecidia and later with the teleutosori.

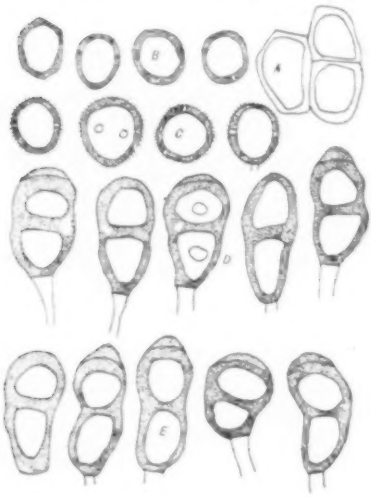

FIG. 4. *Puccinia similis* on *Verbesina Virginica*. *A*, pseudoperidial cells. *B*, aecidiospores. *C*, uredospores. *D*, earlier teleutospores. *E*, later and prevalent type of teleutospores.

Uredospores light brown, broadly ovate to subglobose, 23–26 × 24–28 μ, spinulose: germ pores apparently only two, equatorial.

III. Teleutosori thickly scattered over the entire under surface of the leaves, black, small, from punctiform to .75 mm., naked.

Teleutospores oblong, elliptical to subclavate, 23–33 × 40–54 μ: apex much thickened, rounded, constriction medium, cells usually unequal, lower often triangular, smooth, chestnut brown: pedicel usually shorter than the spore, but sometimes 60 μ long.

On *Verbesina Virginica*, Austin, Texas, Oct., 1900, to Feb., 1901; June to Dec., 1901. Type for I. and II., June 6, 1901, no. 866. Type II. and III., Dec. 1, 1900, no. 50.

The aecidia appear in June, intermixed during the latter part of the month with the uredosori, which continue till Oct., when teleutosori begin to prevail. Specimens of teleutospores collected in February have rust where the host is shaded.

Puccinia ximenesiae sp. nov.

Uredo- and teleutospores intermixed, sori scattered, mainly of teleutospores, on both sides of the leaves, black, orbicular, .5–1 mm. in diameter, semi-firm.

II. Uredospores light yellow, oval to globose, 17–30 × 20–30 μ, epispore echinulate: germ pores two.

III. Teleutospores chestnut brown, oval, slightly apiculate, 30–

34 × 42–50 μ; slightly or not at all constricted in the middle. Cells equal: pedicel short, stout, hyaline.

On *Verbesina encelioides* Gray (*Ximenesia encelioides* Cav.), Austin, Texas, Nov. 16, 1899, no. 65, by W. L. Bray.

This species was reported as common that year, but has not been collected since.

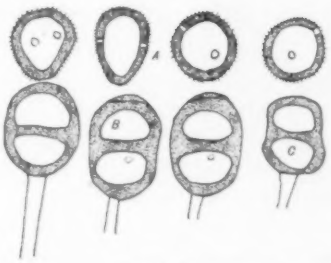

FIG. 5. *Puccinia ximenesiae* on *Verbesina encilioides*. *A*, uredospores. *B*, teleutospores when boiled in lactic acid. *C*, teleutospores when mounted in water.

Puccinia farinacea sp. nov.

Sori amphigenous, powdery.

II. Uredosori cinnamon brown, small, about .5 mm. in diameter, often densely covering parts of the leaf surface.

Uredospores subglobose, light brown, 20–26 μ, echinulate: germ pores two or three, mainly two and very prominent in fresh spores, with a convex cap over each pore.

III. Teleutosori scattered, black, orbicular, .5–1 mm. in diameter.

Teleutospores dark brown, broadly oval to subglobose, 26–30 × 30–34 μ, often apiculate, very slightly or not at all constricted at the septum, upper cell verrucose, lower faintly so: pedicel hyaline, weak, attenuate, about thrice the length of the spores; 1-celled teleutospores sparingly present,

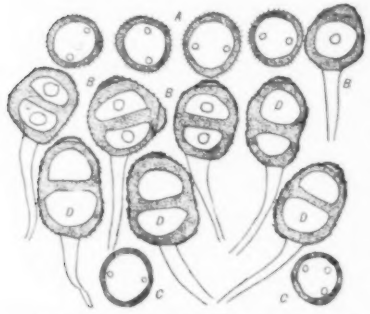

FIG. 6. *Puccinia farinacea* on *Salvia farinacea*. *A*, uredospores. *B*, teleutospores.

FIG. 7. *Puccinia ballotaeflora* on *Salvia ballotaeflora*. *C*, uredospores. *D*, teleutospores.

On *Salvia farinacea*, Austin, Texas, Oct. 31, 1900, no. 826; Nov. 12, 1900, no. 833 (type); April 4, 1901, no. 826 (II.); May 4, 1901, no. 858 (II.), and June 18, 1901. McNeal, Texas, May 12, 1901 (II).

Common on *Salvia farinacea* from April to December. Uredospores from April to October, teleutospores from then till frost kills the host.

Puccinia ballotaeflora sp. nov.

Uredospores intermixed with the teleutospores; light brown, echinulate, germ pores 2–3, oval to globose, 20–28 × 24–27.

III. Teleutosori powdery, mainly on the under side of the leaves, but sparingly on the upper surface; black; scattered, orbicular; punctiform to .75 mm. in diameter; sori on the upper surface mainly punctiform.

Teleutospores chestnut brown, both cells plainly verrucose, apiculate, slightly constricted at the septum, oval to elliptical, 24–30 × 37–50 μ; usual size 26 × 40 μ. Pedicel long, about twice the length of the spores, weak, hyaline, but *fulvous* near spores; somewhat attenuated near base. Septum often oblique or even perpendicular to the insertion of the pedicel. 1-celled teleutospores sparingly present.

On *Salvia ballotaeflora*, San Marcos, Texas, Nov. 19, 1900, no. 836.

The main points of difference between this and *P. farinacea* are as follows: Length and shape of teleutospores; this species having much longer and more elliptical spores; is also plainly constricted at septum, with upper and lower cell strongly verrucose, while *P. farinacea* has lower cell only faintly or not at all verrucose, with entire pedicel hyaline, and *P. ballotaeflora* has pedicel fulvous near the spore.

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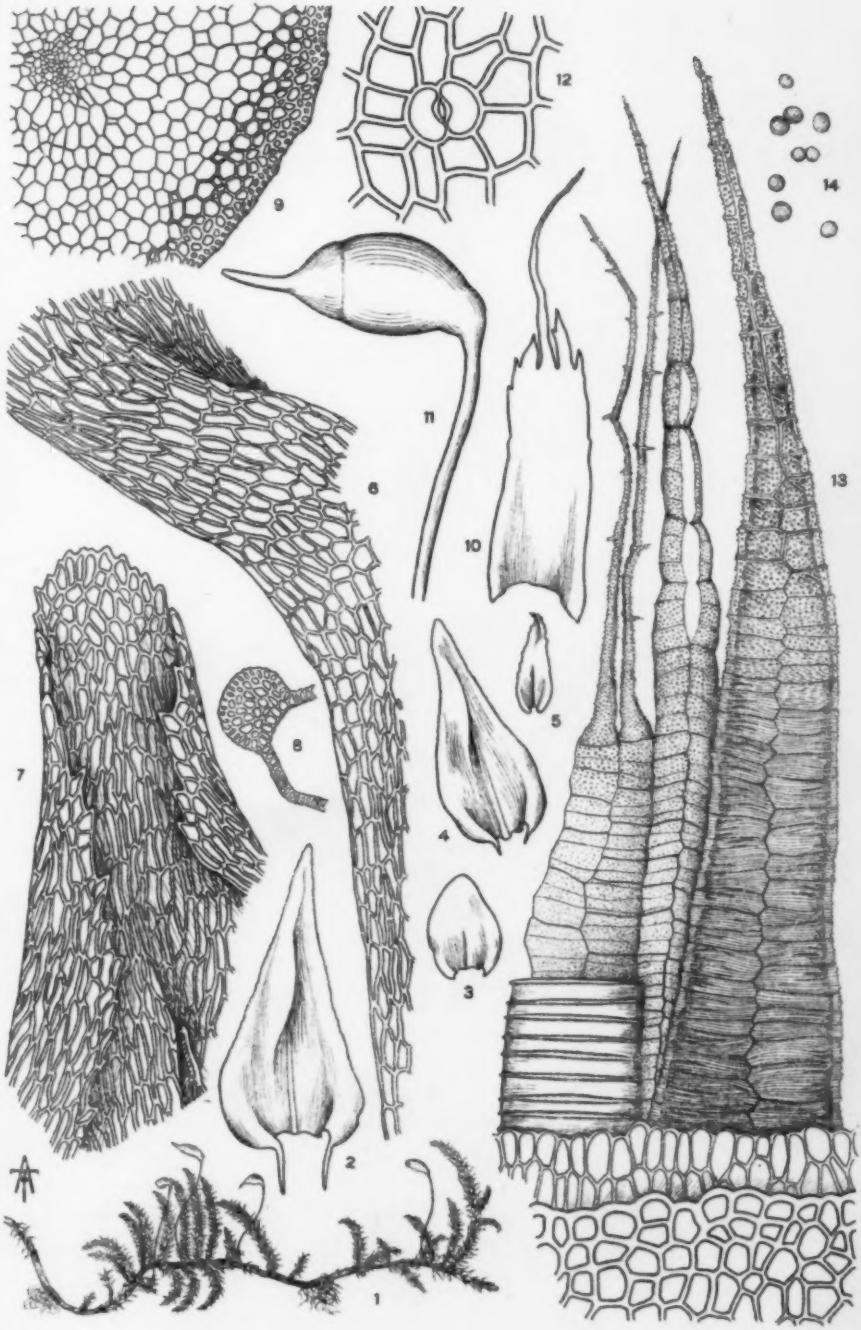
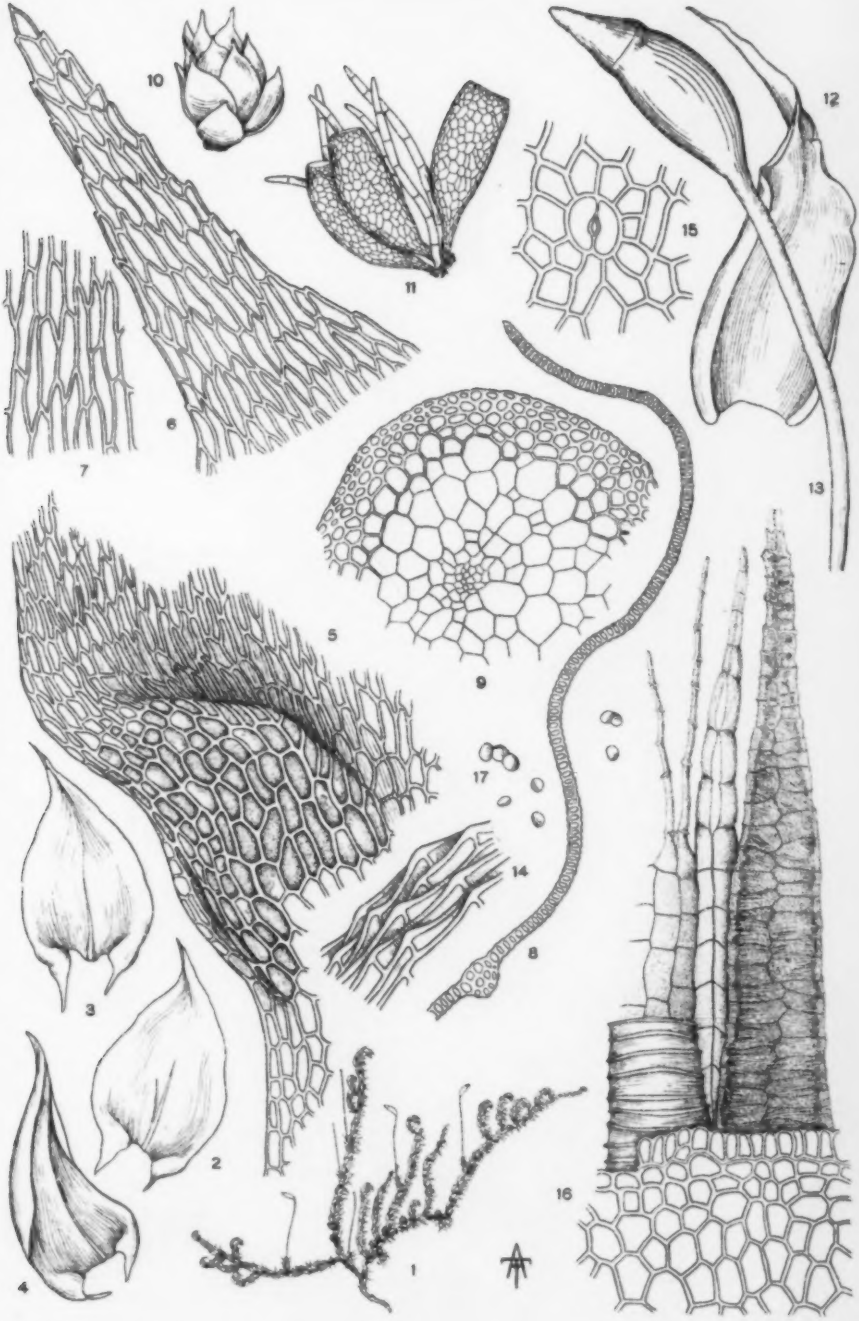


EURHYNCHIUM TAYLORAE

HELIOTYPE CO., BOSTON

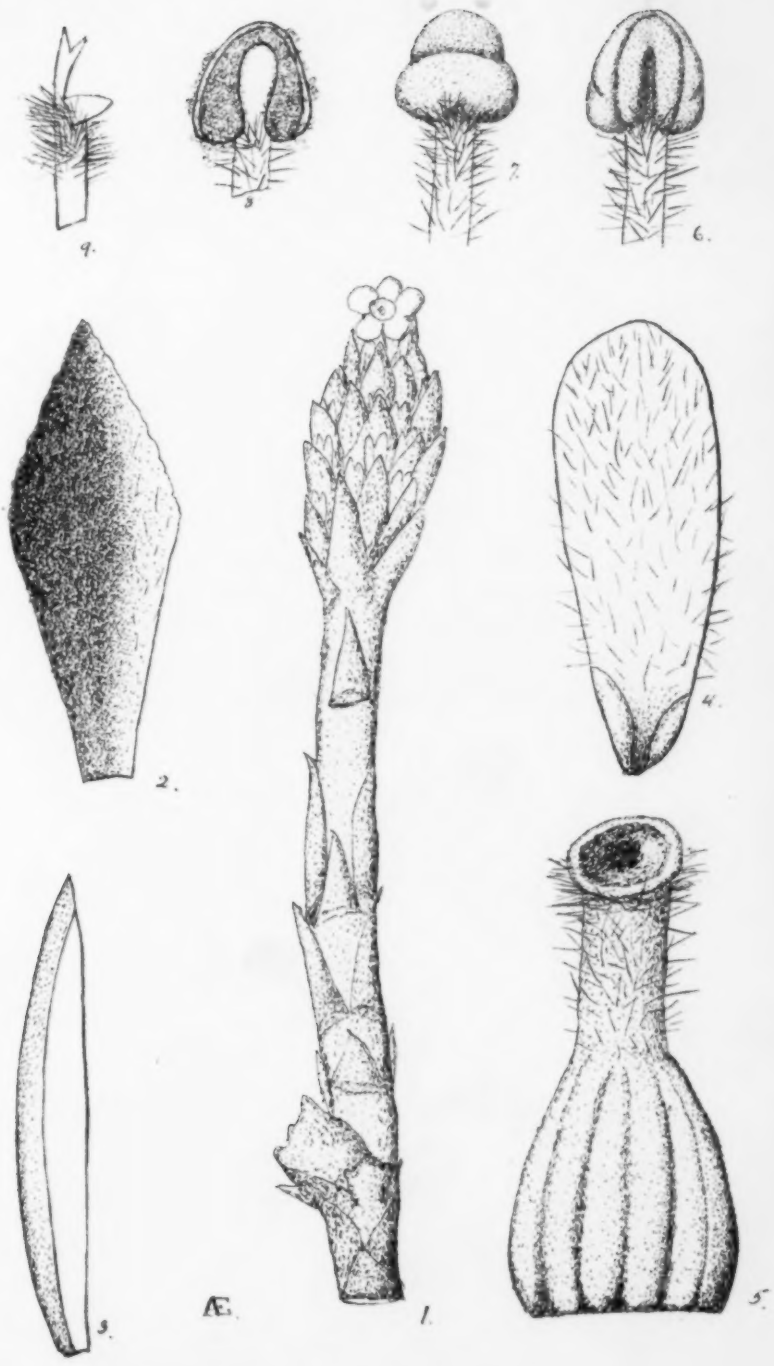


BRACHYTHECIUM PRINGLEI

HELIOTYPE CO., BOSTON

FRITILLARIA PURDYI

HELIOTYPE CO., BOSTON



MONOTROPA CALIFORNICA